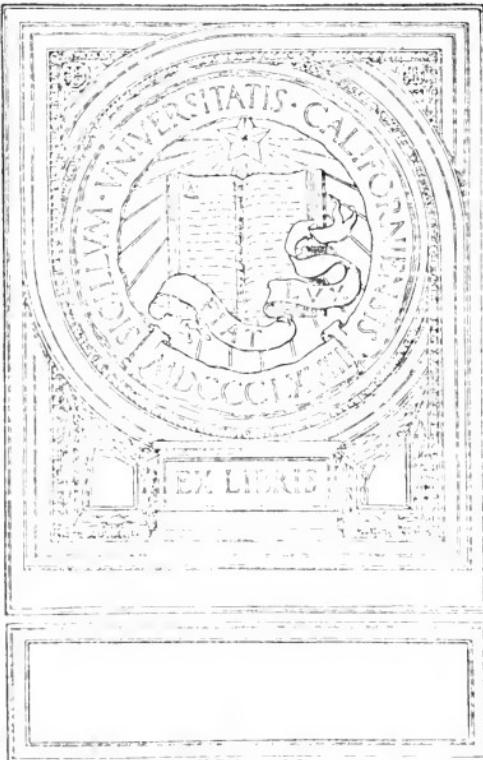
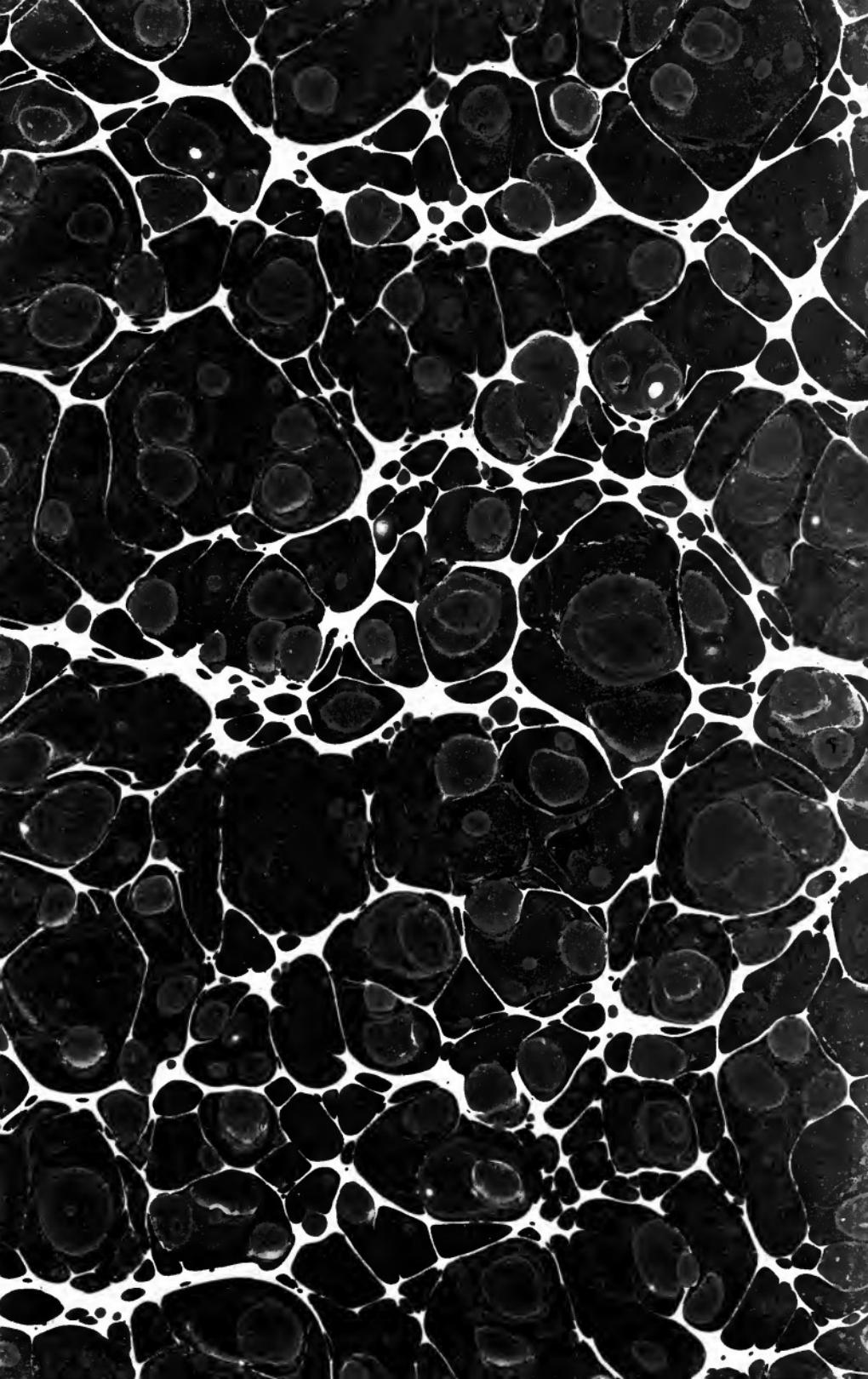


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HOUSE OF REPRESENTATIVES
UNITED STATES

HEARINGS

BEFORE THE COMMITTEE ON AGRICULTURE

ON BILLS HAVING FOR THEIR OBJECT
THE ACQUISITION OF FOREST AND
OTHER LANDS FOR THE PROTEC-
TION OF WATERSHEDS AND
CONSERVATION OF THE
NAVIGABILITY OF NAVI-
GABLE STREAMS

ALSO OTHER PAPERS BEARING
ON THE SAME SUBJECTS

SIXTIETH CONGRESS
SECOND SESSION

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when it is warm, cool

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ACQUISITION OF FOREST AND OTHER LANDS FOR THE PROTECTION OF WATERSHEDS, ETC.

COMMITTEE ON AGRICULTURE,
HOUSE OF REPRESENTATIVES,
Wednesday, December 9, 1908.

The committee met at 10.30 o'clock a. m., Hon. Charles F. Scott (chairman) presiding.

The CHAIRMAN. Gentlemen of the committee, I wish to say that about two weeks before the session of Congress opened I was requested to grant a hearing to some gentlemen who wished to appear here in the interest of the White Mountain and Appalachian forest project. It was too late, then, to communicate with members of the committee individually and hear from them, and I therefore took the liberty of calling this meeting, taking their assent for granted, and I am glad to note the presence of a very large portion of the committee.

I understand that at a meeting held last evening of those who are interested in this matter it was decided to ask Governor Guild, of Massachusetts, to conduct the hearing. Before introducing him, however, I wish to make a few statements touching the attitude of the committee toward this measure, which may, perhaps, have something of suggestion in them to those who are to speak.

In the first place, I wish to say that the committee is fairly well educated on the general proposition. It has been discussed before us at considerable length and by very able gentlemen.

In the second place the opinion of the Judiciary Committee of the House seems to leave this committee with no alternative but to exclude from consideration any question of the purchase of forest lands for the mere purpose of preserving the forests. Under that opinion we can only consider the propriety of such purchase in the event that a direct and substantial connection can be shown between the preservation of the forests and the continued maintenance of the navigability of navigable streams. Therefore, what I think the committee desires particularly to have this morning is facts bearing directly on this latter proposition. We want to know, if any of the gentlemen who are to appear before us are prepared to state it, just how much difference in the stream flow of some individual navigable river can be directly attributed to the deforestation of the watershed contributing to that stream. I think we would like to know if there is any data showing the record of streams for as long a period as possible, covering a period when the forests were in existence and since they have been removed. I think we would like to know whether

the erosion, of which complaint is made as resulting in silting up the streams, is due to the removal of forests from the upper slopes or from the lower slopes of the mountains; whether it is due to the operations of farming or to the operations of lumbering. And I think also we would like to have some information, if it is possible, as to the probable price at which land can be bought in the sections under consideration, and about the number of acres that would probably be required.

In making these suggestions you will understand, of course, Governor Guild, that I am not seeking to dictate what the gentlemen who are to appear before us shall say. I am merely trying to indicate points that must be given very careful consideration by the committee before it acts upon this matter. And with these introductory remarks I take pleasure in presenting to this committee Governor Guild, the distinguished executive of Massachusetts, by whose presence here this morning I am sure we all feel honored.

STATEMENT OF CURTIS GUILD, JR., GOVERNOR OF MASSACHUSETTS.

Governor GUILD. Mr. Chairman and gentlemen of the committee, I am sure that the petitioners in behalf of this measure for the preservation of the Appalachian forests will take due consideration of the kindly suggestions made by the chairman of this committee, and will, to the best of their ability, address themselves to them. I note the remarks of the chairman, that the committee has already given a number of hearings in regard to this matter and has posted itself carefully and quite thoroughly, and therefore I shall ask, to use the legal parlance, if I may put in evidence at this hearing, without reading, the previous proceedings before this committee with the testimony which you already have?

The CHAIRMAN. Certainly, that will be entirely satisfactory.

Governor GUILD. That is understood. I would also like to put in evidence the report of the Secretary of Agriculture on the Southern Appalachian and White Mountain watersheds, which does give the commercial importance, area, condition, feasibility of purchase for national forests, and the probable cost, to which you referred. Furthermore, the report of the Conservation Commission, now in session, which is giving particular attention to the very practical points that the honorable chairman has suggested, in regard to the areas and to the specific effect of the destruction of the forests. Finally, I take it that you do not, of course, desire, as I understand, to exclude any evidence which any person now present may feel desirous of offering as to any deleterious effect that may come to the people of the United States from the destruction of our forests. For if we have to consider, sir, the constitutionality of this measure on the ground as to whether the waters of the river are thereby rendered unnavigable or remain navigable, another clause of the Constitution, of course, provides that Congress is to legislate for the general welfare of the people, and certainly nothing is more for the general welfare of the people than the preservation of a good water supply and a watershed for rivers that furnish water for the use of the people, whether they are navigable or not.

This movement, sir, I need scarcely say, is not of a sectional or local character. The President of the United States, in his address yesterday, declared that the one specific thing that must be done, and done now, for the conservation of our national resources, was the passage of this act for the preservation of the Appalachian forests. He even publicly advocated, if necessary, the issue of bonds by the United States for that purpose, and in that declaration he was seconded by the gentleman who, if not the President-elect, is at least the President elected, Hon. William H. Taft. I suppose it may not be out of place for me to call the attention of the committee, and not in any spirit of controversy and not in any sectional spirit, to another fact. The city of Boston, the capital of the Commonwealth which I have the honor to represent, is the second port of import in the United States, furnishing, with the exception of New York, the largest revenue from customs to the United States Government. New England, Massachusetts, is delighted to have the National Government take up national development. The Commonwealth of Massachusetts, though we have not one square yard of arid soil which needs irrigation in our Commonwealth and have made no petition to the National Government for irrigation, yet sent its delegates to the National Irrigation Congress in New Mexico, to show that the New England States and the Atlantic seaboard are quite as much interested in providing water for the arid lands in the West as we are in providing water for the mills and streams in the East. We do not border on the Mississippi Valley or on the Ohio River, but we are heartily in accord with the movement for deeper waterways for the Central West, and our delegates have taken their part in the deliberations for that great purpose. We shall hope to show you here to-day that the interest which is taken in this movement and the support for it do not come alone from the sections which are to be benefited. The support for it comes from all over the United States, from the West as well as from the East, from the South as well as from the North, and I take particular pleasure in calling the attention of this committee to the fact that I believe that this is the first occasion where the governor of South Carolina and the governor of Massachusetts, have appeared hand in hand together before the National Congress to ask for something for the common welfare of the United States. [Applause.]

The effect of the shortage of water supply caused by the cutting of the trees at the head waters of the streams we shall try to show you has been wide-reaching. The diminution of water power increases the cost of production to our manufacturers, it increases the prices of our products, not only of cotton cloths, but particularly of paper, of which New England, as you know, is the center. It has added to the cost of the production of garden truck and the products of the farm. Finally, I shall endeavor to show you that lack of attention to these forests and the consequent low water in the streams has materially contributed to the spread of disease. The water sinking in the streams causes a deposit of sewage along the banks, and from that springs the dread plagues of typhoid fever and diphtheria, and certainly it is for the general welfare to prevent the death of citizens of the United States by pestilence in time of peace, as well as preserving the equipment of soldiers in time of war.

Something has been said in regard to the extent to which the various Commonwealths might be expected to cooperate with the

National Government if this new movement is crystallized by you gentlemen and your associates into law. Some of the States have already acted. We have recently, in New England, had a New England conference of all six of the New England States, called by the six governors of New England, not merely in regard to forestry, but in regard to other legislation, that state legislation throughout New England may, as far as possible, be made uniform for all the States, and that a confusion of law may not exist. One of the topics there considered was forestry. The papers read and the discussion were submitted to the six state foresters of the New England States, and measures have already been recommended by them for adoption by all the state legislatures. In our own Commonwealth, the Commonwealth of Massachusetts, active work has already been done for the preservation of our forests. Here, for example, are some of the laws of Massachusetts which I will present to the committee, and as you will see from the cover of this little pamphlet, forest fires, especially as caused by railroads, have been made the subject of particular legislation. We have a forest warden for every city and town in the Commonwealth of Massachusetts, charged with the execution of these various laws and with the prevention of forest fires. We distribute free to the people instructions how to collect white-pine seeds and how to plant them. We furnish those to schools. We have had applications from outside of our own Commonwealth for books for children with instructions how to distinguish one tree from another, and how they can be preserved.

The CHAIRMAN. As a matter of fact, the State of Massachusetts is taking care of its own forest problem with its own resources, and is not asking any consideration from the Federal Government?

Governor GUILD. Because, sir, we have no great tract at the head of our great rivers which demands our particular attention. Our great rivers, the Connecticut and the Merrimac, arise outside of Massachusetts, and the amount of land which would there have to be acquired to the extent of the timber land which would have to be protected is, as seems to us properly stated yesterday by the different speakers at the Belasco Theater at the Conservation Commission, beyond the means of any one State to take care of. We are doing this as supplementary work to what we hope the National Government will do, and I am simply quoting this to show that we make this application in good faith, and that we are not relying wholly on the National Government. We have, for example, 23,000 acres of state forest reserves in Massachusetts. Massachusetts is not asking for any national forest reserve in Massachusetts, but she does appear here for her sister State of New Hampshire, and asks that the White Mountains shall be protected by national legislation, because, as I understand, in that region some 600,000 acres will be required, and that is beyond the limits of the treasury of the State of New Hampshire to attend to. Furthermore, New England asks for 600,000 acres for her forest reserve, and she is equally anxious that her southern sisters, to the south of us, should have not 600,000 acres, but if necessary, 5,000,000 acres for the preservation of the entire Atlantic watershed and for the benefit of all the States of the Union. [Applause.]

Mr. WEEKS. It is a fact that 23,000 acres was purchased by a direct appropriation for that purpose, is it not? .

Governor GUILD. Yes; the reserves, as you know. In addition to the state forest reserves, I should say we have great systems of parks in Massachusetts which also include forests. The various municipalities in Massachusetts are planting trees. Our highway commission in Massachusetts plant trees along every one of our Massachusetts state highways. This I am quoting merely to show the good faith in the demand for national action, that we are prepared to supplement your efforts, gentlemen, and that we do feel that the various States in which these forest reserves are located ought not to be asked to pay for them from the limited means of their own state treasuries. I appear as representing one of the Commonwealths which is to have no national forest reserve within its borders, but which will gladly contribute its share of the national revenue to establish forest reserves, not according to political lines, where forest reserves are needed. [Applause.]

I have quoted already the national character of this movement and the support that has arisen behind it all over the nation. I might close with, perhaps, a bit of sentiment, a coincidence if you please, which, nevertheless, is rather interesting. When the United States first gathered together for its war for independence, the first flag of any army from the united colonies, the flag under which Washington took command of the Continental troops under the old elm tree at Cambridge, was a white flag with a pine tree; it was the first flag of the United States Army. When the first American fleet was chartered by George Washington at the siege of Boston, with Commodore John Hardy and a little fleet of fishing schooners, they flew a white flag with a pine tree, and the same motto, "An appeal to heaven." The first flag of the United States Army, the first flag of the United States Navy, under which they began the battle for national existence, was the flag of the liberty tree, the flag of the pine tree. We come before you in peace, as they went forward in war, under the same sign, for the preservation of national health and national wealth, and we ask for the preservation of forests, not in the interest of any one State, not in the interest of any section, but in the interest of the entire American people. [Great applause.]

Mr. POLLARD. Governor, I do not know whether you have ever had occasion to look over House bill 22238, which is a bill I introduced on this subject. I just wanted to ask you this question. I think the committee are all agreed that the object for which you gentlemen are contending is a good one. I do not believe this committee needs any evidence to convince it that something ought to be done. What we want to know is the method, the means to the end, not the feasibility of the end itself. It occurred to me, and I have embodied the idea in this bill, that the Federal Government might, without the necessity of purchasing these tracts of land, supervise the forests and accomplish the same end through the cooperation of the States, as you have suggested, and evade the necessity of the purchase of the lands outright. What little investigation I have given to the subject, and I think the same holds true with some of the other members of the committee, has convinced me that if we enter into this matter, it is not a question of the purchase of 5,000,000 acres of land in the southern Appalachians or perhaps 600,000 acres in the White Mountains, but ultimately it means the purchase of from 65,000,000 to 75,000,000 acres of land in the southern Appalachians and perhaps 3,000,000 in

the White Mountains, so it is a pretty big task. Now, then, if we can accomplish the same purpose without purchasing, why should we not do that? Have you given that subject any consideration?

Governor GUILD. I most certainly have, but I think it will be answered later by some of the various experts on whom I shall call. But I might call your attention, sir, and no doubt it has already occurred to you, that the National Government is already protecting reserve tracts of public land, as, for example, in the Yellowstone Park.

Mr. POLLARD. That is different, Governor; that is part of the public domain. We are speaking of private land now.

Governor GUILD. I understand that, sir, entirely; but it has also found constitutional means to appropriate money for the irrigation of the dry lands of the West, the furnishing of a water supply for those dry lands, and as the President and the President elected and the United States Senate have seemed to find no constitutional difficulty with that, and as the President and President elected seem to think it desirable even to issue bonds, if necessary, I can only say that I cordially agree with their opinions, and we will have it demonstrated in detail later.

I shall now ask Mr. Finney to present various resolutions favoring this project.

(The following resolutions were presented by Mr. John H. Finney, secretary of the Appalachian National Forest Association:)

At the eighty-fifth meeting of this association, held at Saratoga Springs, N. Y., September 30, 1908, the following resolution was unanimously adopted:

"Resolved, That the National Association of Cotton Manufacturers again recognizes the vital importance of conserving the national resources to diminish the growing evils of drought and flood and recommends the passing of laws by States and nation that will apply in correction of loss through fire, waste, and unscientific lumbering, and encourage the planting of new trees necessary to accomplish an increase in our wooded area. It has been fully established by experiences in other countries that competent forest cultivation results in an appreciable increase of timber products.

"We heartily indorse the effective work of the National Commission for the Conservation of National Resources, and recommend that our association cooperate with this commission in furthering our mutual interests."

A true copy from the records.

Attest:

C. J. H. WOODBURY,
Secretary.

RESOLUTIONS IN BE FOREST RESERVES IN THE WHITE AND APPALACHIAN MOUNTAIN RANGES.

Whereas the preservation of forests is indispensable to the national welfare in order that a permanent timber supply may be had and that the water supply of rivers may be maintained and regulated; and

Whereas the effect of denuding mountain ranges of timber is to subject them to torrential action whereby the soil is washed away, the surface rendered barren, the future growth of forest trees prevented, and disastrous floods caused at certain seasons in the lower courses of the streams, with great destruction of property in cities and towns and damage to farming lands in the river bottoms, while at other seasons stream flow is almost suspended and great damage inflicted upon manufacturing industries dependent upon water power and navigation; and

Whereas the unrestricted cutting of the forests upon the White and Appalachian mountain ranges threatens those forests with complete destruction, whereby one of the most important sources of timber supply will likewise be destroyed, irreparable damage be inflicted upon vast manufacturing interests, particularly in the New England States, and the towns and cities in the

drainage area of the Appalachian range be subjected to great harm from annually recurring floods of increasing volume; Now therefore be it

Resolved by the board of directors of the Merchants' Association of New York, That the welfare of the nation requires that the National Government provide, as speedily as possible, for the preservation of forests, especially in mountain regions, the regulation of timber cutting therefrom, and for the conservation of the water supply arising in such forests with a view to lessening floods and maintaining an equitable stream flow for the promotion of agriculture and manufactures.

Resolved, That speedy action by the Congress of the United States is necessary to prevent the destruction of the forests of the White and Appalachian mountain ranges and the evils incident to such destruction, and, therefore, that the Congress is earnestly requested to enact into law the measures now pending for creating forest reserves in the regions named with a view to preserving the forests thereof by restricting and regulating the cutting of timber and promoting new growths.

NEW YORK PRODUCE EXCHANGE,
New York, December 4, 1908.

Mr. W. M. CROMBIE,
81 New Street, New York City.

DEAR SIR: At a meeting of our board of managers, held yesterday, I brought up the matter of forestry conservation and replanting, and after discussion the inclosed preamble and resolutions were unanimously adopted.

I am sure these resolutions embody the sentiment of practically our entire membership, as we are all fully in accord with the desire to preserve our forests for the general benefit of the country.

I send you these resolutions, and you have permission to use them in any way that you may deem most advantageous.

Yours, very truly,

WELDING RING,
President.

Whereas the constant cutting off of our forests, which is rapidly increasing every year, and only very limited efforts being made to restore this timber by replanting; and

Whereas this destruction of our forests and woodlands is very greatly affecting our climate by the quick drying up of our streams and reducing the water supply of our lakes and rivers, thereby seriously interfering with navigation; and

Whereas these conditions can be materially changed for the better within a reasonable period by systematic and constant replanting and by proper reservation of lands for forest reserves:

Resolved, That the New York Produce Exchange earnestly requests and urges the passage of one or more of the bills now under consideration by the National Congress, providing for the reservation of forests and replanting of woodlands.

RESOLUTIONS ADOPTED BY THE DIRECTORS OF THE LOUISVILLE BOARD OF TRADE AT A MEETING HELD ON JANUARY 22, 1908, FAVORING THE ESTABLISHMENT OF THE PROPOSED APPALACHIAN NATIONAL FOREST.

Whereas official statistics show that the people of the United States face, within a decade, a lumber famine due to wasteful and extravagant use and wanton methods of cutting; and

Whereas our Appalachian forests are now being rapidly depleted and are about our only remaining source of hard-wood supply; and

Whereas we recognize that forest coverings are essential not only to our timber supply, but are of supreme importance to climate and agriculture, to water supply and navigation; and

Whereas the cutting already done has shown its baneful effects throughout the South, and demonstrates forcibly from many standpoints the necessity of the conservation of this source of our natural wealth; and

Whereas the perpetuation of our forests can only be done by the National Government: Be it

Resolved, That the Louisville Board of Trade, of Louisville, earnestly urges upon the Congress of the United States the establishment of national forests in the Appalachian region by the prompt passage of the Appalachian-White Mountain bill.

Resolved, That a copy of these resolutions be sent by the secretary of the board to all Congressmen and Senators from this State, requesting their hearty and active support and their vote for the measure.

RESOLUTIONS.

CHARLES TOWN, W. VA., November 26, 1908.

Whereas there is pending before the House of Representatives and is before the Committee on Agriculture Senate bill 4825, providing for the establishment of the Appalachian-White Mountain National Forest; and

Whereas the establishment of this forest area is deemed of vital concern to the South and to New England, as well as to the nation at large: Therefore be it

Resolved by the Board of Trade of Charles Town, W. Va., having a membership of 75, That we most earnestly indorse the project of establishing such national forest, and urge upon the Congress immediate and favorable action thereon.

Be it further resolved, That we urge the adoption by the Congress of a systematic, progressive, and definite forest policy, which will insure the extension of the national forests to all sections of the country where they may be constitutionally established.

That a copy of these resolutions be sent to our Senators and Representatives in Congress and to the Appalachian National Forest Association, Washington, D. C., for presentation before the House Committee on Agriculture December 9, or such other date as may be set for the public hearing on the bill.

Adopted November 26, 1908.

S. M. OTT, President.

[SEAL.]

Attest:

W. I. NORRIS, Secretary.

Resolutions similar to the last above quoted were submitted by the following: Engineers and Architects' Club, Louisville, Ky.
Greater Charlotte Club, Charlotte, N. C.
Chamber of Commerce, Washington, N. C.
Chamber of Commerce, Huntington, W. Va.
Mobile Chamber of Commerce, Maritime Exchange, and Shippers' Association, Mobile, Ala.

Commercial Club, Cloverport, Ky.
Columbia Chamber of Commerce, Columbia, S. C.
Commercial Club, Montgomery, Ala.
Chamber of Commerce, Roanoke, Va.
Chamber of Commerce and Industry, Raleigh, N. C.
Mass meeting of citizens of Toccoa, Ga.
Chamber of Commerce, Augusta, Ga.
Board of Trade, Appalachicola, Fla.
Pulaski Board of Trade, Pulaski, Tenn.
Business Men's Club, Wolfe, W. Va.
Chamber of Commerce, Spartanburg, S. C.
Board of Trade, Clarksburg, Tenn.
Board of Trade, Nashville, Tenn.
Tobacco Board of Trade, Oxford, N. C.
Young Men's Commercial Club, Talladega, Ala.
Business Men's Association, Mebane, N. C.
Commercial Club, Johnson City, Tenn.
Business Men's Club, Memphis, Tenn.
Builders' Exchange, Louisville, Ky.
Newbern Chamber of Commerce, Newbern, N. C.
Chamber of Commerce, Elizabeth City, N. C.
Belington Board of Trade, Belington, W. Va.

STATEMENT OF MR. JOHN G. RUGE, VICE-PRESIDENT OF THE SOUTHERN COMMERCIAL CONGRESS.

Mr. RUGE. It is my pleasure and privilege and honor, as vice-president of the Southern Commercial Congress, to present to you a resolution adopted yesterday, which reads as follows:

The Southern Commercial Congress in convention assembled, with accredited representatives of 64 commercial organizations from the 15 States participating therein, does resolve as follows:

Deeming the establishment of the proposed Appalachian White Mountain National Forest of paramount importance to the nation, and realizing the urgent necessity of immediate congressional action thereon, we commend the Senate in passing the bill; we deplore the delay of the House of Representatives and its Agricultural Committee in withholding favorable action upon it; and we unite, as earnest and patriotic believers in the utmost conservation of our national resources, of which the forest is certainly one of the most important, in this expression of dissatisfaction in any further delay.

And we further instruct the chairman of this congress to appoint a committee of this body to attend the hearing before the Agricultural Committee on Wednesday, December 9, and to express in no uncertain terms our attitude in this matter.

Governor GUILD. I have asked our representatives here to-day to confine their remarks to the five-minute limit, and with your consent, sir, shall notify them when their time has expired.

The CHAIRMAN. That will be satisfactory to the committee, with the understanding that, in fairness to the gentlemen appearing, if the committee protracts their time with questions of its own the limit will not be enforced.

Governor GUILD. We appreciate your kindly courtesy, sir, and merely desire to reciprocate.

As the first speaker, especially as he is obliged to attend duties in the Senate chamber shortly, I shall call upon the Chaplain of the Senate, the Rev. Edward Everett Hale.

STATEMENT OF DR. EDWARD EVERETT HALE, CHAPLAIN OF THE UNITED STATES SENATE.

Doctor HALE. The reason why Governor Guild calls upon me is that I am the oldest person hereabouts who has really worked in the New Hampshire forests. I had the good fortune, when I was 19 years old, as a boy, to serve on the Geological Survey in the State of New Hampshire. I have slept under these very pine trees which have long ago been cast down, and within two years I went over the absolute ground, where there was not a stick as big as that stick I have to lean on now. It makes a man cry, when he has slept under a pine tree 10 feet in diameter. I have talked with men who saw George the Third's "broad arrow" on trees, which the King would never permit to be cut down—and now to see the places where they grew growing up in blackberry bushes. I respect entirely what the chairman has said as to the nature of the testimony desired by the committee, and I will try to confine myself within that limit.

When I was here a year ago the question had not been raised, even as an academic question, as to the right of this committee to do anything about it. The chairman informs us that it has been raised since. I went from this room then and addressed a note to the Navy

Department and to the Land Office, and asked them to send us the particulars about the purchase, more than one hundred years ago, by the Navy Department, of lands at the South, because they had live oak upon them, from which the department wanted to build our frigates and vessels. The Land Office and the Navy Department together were kind enough to furnish those documents, and they are the evidence that more than one hundred years ago the nation was in the habit of buying land, owning land in fee simple, from different States and from different individuals all through the South because it had live oak upon it, and that covers completely every statement which gentlemen have wished to make here with regard to that. Those papers can be obtained by the chairman and by yourselves.

Speaking about denudation, I do not think there is any lesson that the committee can learn outside of the hills of New Hampshire themselves as to what we mean by denudation. In the old days, of which the governor has spoken just now, these pine trees were employed in the American Navy. Mr. Chairman, in the great battles of 1780 and 1781, when the British navy was engaged, when the American Navy was engaged, when the French navy was engaged, when the Spanish navy was engaged, every spar used by every frigate, probably, and every man-of-war was from the New Hampshire and Maine forests. Up until 1775 the export of these spars had been necessary, and every navy-yard in western Europe and every fleet in all the great naval encounters flew their flags from flagstaffs supplied from the New Hampshire forests. In the last ten years, I was going to say, there has not been a spar as big as that cane sold from a New England forest, and why is it? It is because in the present business of lumbering—the very paper you are writing upon is made from spruce timber cut down up there. A lumber baron will send his men in, and he says, "Oh, do not pick out the good trees; cut down everything." It is so much easier to clear the whole thing, make a clean sweep of it, that the denudation goes forward as it did not go forward in the days when I was a surveyor there. In those days the man who sold lumber sold timber which was of use to cut up. Now, if he can sell a stick as big as my arm he can make as good paper out of that stick as he can make out of a big log, and therefore the instructions to the workmen are to cut down everything and to leave nothing.

Then comes a God-appointed shower, and the shower washes off everything, because you have nothing to hold back the water. It washes off everything. It washes off all the soil, everything that will go. It washes off everything but large stones. So, when Governor Guild and I go up there with our nice pine seed and plant them there they will not grow. You have swept away the soil, and you have nothing left but gravel and rock.

The plea, therefore, for the preservation of the forests, that has now become a national plea, is a plea made necessary on account of the uses made of the timber when it has been cut down, and I beg that you put in as a part of the statement we make that the cutting down of the forests now leaves the thing as bare as that table, you might almost say, and it sweeps down the soil, and the governor has told you what becomes of it. It lies on the shores of the rivers and creates malaria and all those evils.

The precise position of the State of New Hampshire has been alluded to. I am a resident of that State every summer; in fact, I officially represent here a body of the people of one of the valleys there, who were kind enough to make me the chairman. That State, the chairman must remember, includes not only the waters of the Connecticut River, but the waters of the Androscoggin River, which rise in the State of Maine. I do not think, Mr. Chairman, that anybody had dreamed, when I was here a year ago, that this committee had not full power to act in that purpose. I think it was an academic question which came up afterwards, when our friends say the Judiciary Committee sent down to you and said you could not do certain things which you wished to do. But it seems to me that the question of the live-oak lands is an interesting one, and it shows that the people one hundred years ago thought they had that power, and if that does arise, it shows that the conditions of timber cutting are wholly different from what they were one hundred years ago.

I see the chairman looking at his watch, and I only allude to the question of the bonds, and if you will fix it so that the Government will take care of the forests as Bavaria and other European countries have, fifty years hence you will have a larger revenue from your forests and you will pay for your bonds with them.

STATEMENT OF HON. JOHN H. STEPHENS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF TEXAS.

Mr. STEPHENS. Mr. Chairman, I desire to state that I have a bill on all fours with the Appalachian and White Mountain bill, for protecting a natural forest growing on the headwaters of the Red River in the plains of Texas, extending almost to the eastern side of New Mexico. We have organized, in the southwest four States, into a congress known as "The Red River Improvement Association." We passed resolutions requesting that 100,000 acres of land be purchased on the headwaters of the Red River for the purpose of protecting the forests there, and the conditions will not exist as described by the last speaker if Congress would purchase this land and protect the timber there now, which will not require being replanted. Neither will the conditions exist that exist at present in the Southern Appalachians, but the land has passed from the State of Texas; it no longer belongs to us. One-half of it was given for the purpose of building interstate railroads running across the continent, the Texas Pacific and the Southern Pacific, and that is the reason we have not any public domain left there, mainly because we gave away one-half of it for the purpose of building our railroads. So we now ask that the Government appropriate \$500,000 for the purpose of purchasing 100,000 acres of land as a forest reserve and a park on the headwaters of that river. This is joined in by all of those States and by various cities and towns and various associations, and I will now ask leave to file these, together with the numerous maps and documents obtained from the Forestry Bureau and other documents of interest in this matter, with your committee for your investigation.

The CHAIRMAN. Without objection, the papers will be filed.

Be it remembered that at the second meeting of the Red River Improvement Association, held in Denison, Tex., on November 6, 1908, the following resolution was unanimously adopted:

"Resolved, That we favor the passage of the bill now pending in Congress to create a national park and timber reserve in the canyons forming the head of Red River, believing the preservation of the forests to be essential to the improvement of Red River."

Respectfully submitted.

JNO. H. STEPHENS,
Author of bill referred to, etc.

To the chairman Red River Improvement Convention:

We, your committee on forest reserve, beg leave to submit the following report:

Whereas this convention, recognizing the great natural resources of the Red River Valley and of the paramount importance of restoring navigation on the Red River, not alone to the people along said river, but to the nation as well, and of the importance of preserving and fostering of the native timber at the head of and along said river and its tributaries; and whereas the Hon. John H. Stephens, Representative in Congress from the Thirteenth District of Texas, has introduced in Congress a bill seeking to have a national park established in the Palo Duro Canyon, in Randall and Armstrong counties, Tex., on the headwaters of Red River.

Therefore we indorse said bill and recommend that the same be passed by Congress at its next session, and further recommend that this association take steps to encourage the people along the Red River and its tributaries in systematically preserving the natural forests along said stream and its tributaries and engaging in fostering the growth of timber as well.

We further recommend that the secretary of this organization be requested to furnish a copy of this document to the Senators and Representatives in Congress of the States of Texas, Oklahoma, Louisiana, and Arkansas and request their united efforts in support of the above measures.

Respectfully submitted.

J. W. CRUDGINGTON,
Chairman, Amarillo, Tex.

HENRY COX, *Fulton, Ark.*

H. P. MAYER, *Paris, Tex.*

S. R. CRAWFORD, *Graham, Tex.*

J. B. LEEPER, *Denison-Sherman, Tex.*

H. G. EVANS, *Bonham, Tex.*

HUGH CORRY, *Alexandria, La.*

R. D. BOWEN, *Paris, Tex.*

Mr. STEPHENS. If the governor of Massachusetts will permit me, I will inform him that the governor of Texas will take pleasure in joining with you and with the governor of South Carolina, and with greater zeal, because she is much larger than all the Southern States and all New England combined. [Laughter.]

Governor GUILD. And you might add one more thing, that the other States joined together to make a nation, but Texas as an independent nation joined the United States.

Mr. STEPHENS. The gentlemen must remember that Texas annexed the United States. Texas was an independent government itself, and I always contend that Texas annexed the United States, and not the United States Texas. [Laughter.]

Governor GUILD. There is no compliment which you can pay to the Lone Star State which we of New England will not take pleasure in joining with you.

I take pleasure in presenting as the next speaker a gentleman who is obliged to leave very shortly, and I therefore will introduce him out of order, one of the governors of the West. I take pleasure in presenting Governor George E. Chamberlain, of Oregon.

STATEMENT OF GOVERNOR GEORGE E. CHAMBERLAIN, OF OREGON.

Governor CHAMBERLAIN. Mr. Chairman and gentlemen, I am here at the request of some of the distinguished gentlemen from the Northeast to join with them on the part of the Northwest in furthering this movement. I desire to say that Oregon has at least one-fifth, probably a little more than one-fifth, of her area in the federal reserves, and that area embraces the most magnificent forest reserves of the whole western country. Until the Government established these reserves and took control of them there was very little done toward forestry protection, but since the Government has taken charge these forests have been better preserved, trespassers are in greater fear of the Government than they ever would be of any of the state authorities, and the results there are splendid. I want to say that I believe that some policy ought to be taken by Congress to acquire, not in the name of the State, but in the name of the United States, those deforested areas, not only in the Northeast, but along in the Appalachian Range as well. The suggestion has been made that possibly the same end might be subserved if the title remains as it is, or possibly in the State with federal supervision, but it seems to me that in order to accomplish results these lands ought to be purchased by the Federal Government, either by agreement with the parties who own them or by the exercise of eminent domain, if that can be done, and I think it can be. Not only will it be necessary for reforestation of the deforested areas, but it seems to me it will eventually become necessary to expropriate, if I may use that term, the ownership in the water powers as well as in the deforested areas. So I want to say that the Northwest heartily joins in this movement, and I think that the Government, if it does not do it now, will be compelled in the very near future, for its own protection, to buy these areas.

Governor GUILD. I need scarcely remind you gentlemen that Governor Chamberlain spoke for the governors of all of the United States in response to the address of the President.

I present as the next speaker the president of the University of Wisconsin, Dr. C. R. Van Hise.

STATEMENT OF DR. C. R. VAN HISE, PRESIDENT OF THE UNIVERSITY OF WISCONSIN.

Doctor VAN HISE. On yesterday afternoon I had no expectation of saying anything in reference to this matter to the Committee on Agriculture, but the men who are especially interested in this measure in the southeastern part of the United States asked me to say a few words in reference to the condition of that part of the country. As a member of the Geological Survey for a number of years I had charge of the work in that region, and therefore traveled extensively over it all the way from Virginia to Georgia. I am therefore somewhat familiar—indeed very familiar—with the actual situation in that region. I am not going to undertake to present the details upon which the conclusion is reached that this upland region should be reserved as a forest, since I understood one of the members of the committee to say that that point was already conceded; that it was admitted that it was extremely desirable—indeed, almost necessary—that this great upland region be reserved as a forest.

However, there is just one point in connection with that to which I wish to call your attention. It is this, that this region is one in which the conditions are especially critical. In the northeastern part of the United States—and I am not talking against the White Mountain reserve, for I believe in it—in the northeastern part of the United States, or in the northern part of the United States, below the surface there is a sand and gravel which makes a porous stratum which carries water. In this southeastern part of the United States the rocks have not disintegrated and are nonporous; there is clay. The water does not readily find its way into them, and the result is that it gathers upon the surface very readily and very easily into streams of considerable power, and is therefore especially potent in this matter of erosion. Every one of you who is at all familiar with the region in the southeastern part of the United States must have appreciated how much more extensive the erosion is in that region, even on slopes of moderate steepness, than it is in these other regions in which the conditions are less crucial, and therefore I wish to urge that in this particular the southern Appalachian forest region has an exceptional demand for attention. I unhesitatingly assert that somehow, for the good of the States and the nation as a whole, it is absolutely necessary to preserve the protective covering of vegetation on this upland area of the southeastern part of the United States. But that I understand to be conceded, and therefore I shall not dwell upon it. So that the question comes back, How can this great task be accomplished? Why should the Government undertake a portion of its accomplishment?

In the first place, it is a tremendous task; a task of such magnitude that to properly accomplish it will require, it seems to me, the joint efforts of the nation, of the States, and of the citizens. But if it is merely a local interest, why should the nation participate? And that, of course, is the crucial question, from your point of view. It seems to me there are two very good reasons, one of which has been suggested to me since I came into this room, why the nation ought to participate, why they will find it economical to participate in this matter. In the first place, the nation is taking up the question of improving its waterways, to maintain a uniform and equitable flow. There is talk of spending not five millions, or ten millions, but scores of millions of dollars in the improvement of inland waterways. This vast expenditure which is necessary can be reduced, in my judgment, and I think if time were sufficient it could be proved that it could be reduced if the problem is studied at the head instead of the foot; that is, if the forests are preserved, if the covering vegetation is preserved, a uniform and equitable flow of the streams is produced.

The question may be asked, Is it a fact that in consequence of the removal of the forests floods have increased? Does the water go down more rapidly at one time and less rapidly at another in consequence of the removal of the forests? In reference to the Tennessee River, one of the long streams which heads in this region, that is unquestionably true. The most careful investigation which has ever been made in this country upon the relation of forest covering to stream flow has been made by Mr. Leighton of the United States Geological Survey during this past summer. This investigation has taken into account not only the number of floods during the past twelve years and the previous twelve years, but the number of flood-producing

rains, for an investigation which does not take into account the number of flood-producing rains is very imperfect. I can not, of course, in the five minutes time present these results in detail. I will sum it up in a sentence and leave the question to be proved by Mr. Leighton in case you desire it, but the result of his investigation shows that as a consequence of the change of conditions due to deforestation during the past twelve years the floods are 18.75 per cent more frequent than they were during the previous twelve years, taking into account the precipitation, the number of flood-producing rains, as well as all the other factors. This is the first investigation which has been made, and this investigation concerns directly this southern Appalachian forest reserve.

Now, the second point is this: The Government spends millions of dollars in dredging out harbors, and yet no effort is made by the Government to prevent the silt from going down into harbors and filling them up, and so that process goes on year after year and year after year and must continue to go on, because it will never be possible to altogether prevent the silt from going down into the harbors.

The CHAIRMAN. Has it not always gone down?

Doctor VAN HISE. It has always gone down.

The CHAIRMAN. Does not the location of the great bar at the mouth of the Columbia, which has existed ever since navigation discovered that access, indicate that there has been very severe erosion through that watershed from time immemorial, and extending through a time when the watershed was just as perfectly protected as it ever could be by forests?

Doctor VAN HISE. That is entirely true. There never will be a time in which the silt will not be carried down into the harbors and rolled over and over and carried along by the waves meeting the current. There never will be a time when that is not the fact, and there never will be a time in which the harbors will not fill up. But the amount of silt that is carried down from the mountains has been vastly increased as a result of this deforestation.

The CHAIRMAN. Is that merely a deductive opinion, or is it a demonstrated fact?

Doctor VAN HISE. It is a demonstrated fact, as it seems to me, from the results of these very investigations that have been made with reference to the Tennessee. There is no question on the part of anybody that the erosion in the South and in the headwaters of these streams, as the result of the removal of the forests, has gone on at a speed which never occurred before. That is to say, before the forests were removed the forces of nature were making the soil faster than it was being washed away, so that the soil was ever getting thicker and thicker and thicker. Wherever the forests have been removed, and especially on the steeper slopes, erosion has gone on faster than the making of the soil, so that the bare rocks are protruding, conclusive proof that there has been carried down with the streams, and ultimately to the mouths of the streams, much more material than was carried down under conditions of forest cover.

The CHAIRMAN. Has any investigation been made to determine what proportion of the soil, eroded from the slopes at the headwaters of a stream like the Tennessee, reaches the navigable portions of that stream?

Doctor VAN HISE. There will be a direct relation, unquestionably. It will not reach it at once. Of course the silt picked up high in the mountain is carried part of the way down with this flood and it is dropped on the way; then another flood comes along and it is carried a little farther down and dropped again, and ultimately it either reaches the outlet and fills the harbor or else flows over its banks and destroys the farming lands, as in California, where sand and gravel have been distributed over the lowlands as a result of hydraulic mining operations. I do not hesitate to assert that the silt and loosened material that goes down in the Appalachian and White Mountain regions, if those regions were denuded, would be fully one hundred times as much as has been washed down in the rivers of California as a result of hydraulic mining operations.

The CHAIRMAN. You are very familiar with the Southern Appalachians?

Doctor VAN HISE. Yes, sir.

The CHAIRMAN. In your opinion has the erosion which has thus far taken place come from the operations of lumbering or from farming?

Doctor VAN HISE. Mainly from farming as yet, but of course it is a twofold thing. It naturally happens that when the timber is removed it is removed from the more accessible areas. When once it is removed from an accessible area that accessible area will be made into a farm. Combination of the two results in the erosion. Undoubtedly there have been mistakes in this particular. Some areas from which the timber has been removed, or removed in part, should never have been made into farms. They are too high up, the slopes are too steep, so that the erosion goes on with excessive rapidity, and therefore it can not be asserted to be one or the other; it is the result of both.

The CHAIRMAN. Very large sections of the Appalachians have been lumbered. All the valuable merchantable timber has been taken out. In such sections have the lumbering operations gone to the extent of contributing very greatly to the erosion?

Doctor VAN HISE. I think they have. I want to be perfectly fair and express the things in absolute proportion. I do not believe that the lumbering operations alone, in case the lands had not been farmed afterwards, would have resulted in as great erosion as has resulted from the farming operations after it on lands not adapted to farming. The great difficulty has come as a result of lumbering operations followed by farming operations on lands that never should have been taken for farming.

The CHAIRMAN. You know, of course, that the clearing of the slopes for farming in the southern Appalachians has been under the compulsion of necessity. Men have been obliged to find some place upon which to earn a living, and they have cleared certain of the most accessible slopes. They have not deliberately and with malice aforethought gone and taken the steep and almost inaccessible slopes when other land was available. We are obliged, therefore, to take into consideration the conditions that exist and which have resulted as a mere incident of civilization. Remembering that, and remembering, as I think we also must, that the people of North Carolina, for example, must continue to live in North Carolina—we can not depopulate the State and send it back to the wilderness—I would like to ask you, if you were commissioned by the Government to buy land in North Carolina for the conservation of the stream flow, would

you purchase the lower slopes or the upper slopes of the mountain? And I want your scientific opinion.

Doctor VAN HISE. I shall give you my best judgment of the matter. My principle of action would be this: Upon the whole, from the point of view of the nation, is this land more valuable to the nation for agricultural purposes or for the purposes of forestry and the regulating of the streams? If, upon the whole, that land, using the best data and judgment, if the slopes were such, the soils were such, the conditions were such that the land could be used for a reasonable length of time, with care practically perpetually, for agricultural purposes, certainly it should be used for agricultural purposes. But if the slopes are so steep that that is not practicable; if the slopes are so steep that it is not economical to do that; if the slopes are so steep, as in the Balsams, for instance, where the land will be gone in five years, that never should have been allowed to become an agricultural tract, and if under those circumstances that land has become an agricultural tract, it should be reconverted into a forest tract.

The CHAIRMAN. Governor Guild, let me say aside, you will pardon me for taking this time with Mr. Van Hise, but it is because we know he is an expert on this question, and I think we can get some information, and I am sure the committee will extend the time.

Governor GUILD. Certainly, Mr. Chairman.

The CHAIRMAN. Now, Doctor, leaving out of account the question of the rights or the necessity of the people to live in North Carolina, as a scientific proposition, if you were commissioned to buy the land and had to take your choice between the lower third and the upper two-thirds of the ranges, and your only purpose in buying it was to conserve the stream flow, which would you buy?

Doctor VAN HISE. I would buy the headwaters of the streams.

The CHAIRMAN. You do not understand my meaning. I say, Would you buy the lower slopes of the mountains or the upper slopes, assuming that you could not get both, but that you would take the one which would most conserve the stream flow?

Doctor VAN HISE. I can not make quite a satisfactory answer to that, because the erosion depends on two things—on the steepness of the slope and the volume of the water; and, of course, the lower down the slope you are, the heavier the volume of water is. Therefore those uplands which should be selected first should be those uplands in which the slopes are so steep that if converted into agricultural lands they would be practically destroyed, but low enough down so that they would be where the erosion would be likely to be the greatest. I would not select the tops of the mountains, the flat tops, because the lands on the top there would not be so easily washed off because they are flat, in the first place, and because, in the second place, the stream currents are not strong. But after you get over the top and down these slopes here and the streams have gotten the volume so that the erosion would be great and the slopes are steep there; joining those two factors together and picking out the area in which the damage would be the greatest by the removing of the forests; those would be the areas which I should select if it were left to me.

The CHAIRMAN. Suppose I had a cone here approximately the shape of a mountain, sitting in a panfull of water; suppose I tie a sponge

tightly about the upper two-thirds of that cone and sprinkle lampblack over the lower third, and then have an artificial rain falling on the whole cone. The water in the pan would be discolored immediately, would it not, by the washing of the lampblack?

Doctor VAN HISE. Undoubtedly.

The CHAIRMAN. Supposing now we reverse the situation, sprinkle the lampblack over the upper two-thirds and bind the sponge tightly on the lower third of the cone, then have your artificial rain; is it not likely that the sponge would serve as a sort of filter and hold a large proportion of the lampblack, and the water would not be so discolored?

Doctor VAN HISE. That is so, but I would question, if you may permit me, the applicability to the case. This lower land is not a sponge, but it is, as I have explained, impervious, relatively, and is soft enough so that it can be removed.

The CHAIRMAN. All the advocates who have come before us have compared a forest to a sponge. That is the reason I used the illustration, and my application of it was this: That with the forest sponge upon the lower slopes of the mountain, any erosion from the upper slopes was much more likely to be retained and held and not to get into the streams than if the upper slopes should be protected and the lower slopes left bare, because then when erosion begins there is not anything to filter the water, and it carries its load of soil into the stream. My observation through that country has been that erosion always takes place, if the lower slope is bare, no matter what the declivity may be, and no matter whether the upper slope is covered or not. It does not always take place if the upper slope is bare, while the lower slope is left covered.

Doctor VAN HISE. I would not dissent from that. I did misunderstand. I feel I am taking too long a time, but I would like to put the actual conditions before the committee. The cone does not cover the case, because the mountains are not cones. The mountains are mainly flat-topped ridges and valleys. Supposing this to be a mountain [illustrating]. The condition is represented by that kind of a curve. You start with a flat top, in that way, and you go down the curve, getting steeper and steeper. The Hogarth line of beauty represents the curve of the valley to the top of the mountain. I would quite agree with the chairman of the committee that this part away up here would not be the part that is most eroded, because the streams have not gathered sufficient volume, nor would the valley lands, which would be this belt in between, where the streams have gathered sufficient volume to become powerful and where the slope is steep. If you premise here a belt, the forest being down here, it will in a measure stop and check the work of erosion that is going on higher up.

The CHAIRMAN. That being true, does it not follow that if you are going to protect the hills, and in that way protect the streams from silting up, you must keep the forest cover on the intermediate slopes that you speak of, rather than on the upper slopes?

Doctor VAN HISE. Yes, sir.

The CHAIRMAN. If that is true, the suggestion which has always been made before this committee, and which is the whole burden of the report from the Secretary of Agriculture last year on this question, that we must preserve the upper slopes, has proceeded upon a mistaken hypothesis?

Doctor VAN HISE. Of course, as I understand it, this bill does not designate the particular lines to be selected. It is to be supposed that the Secretary of Agriculture, in case the bill is passed, would have that selection made by men who best understand the forestry and erosion, and therefore, we think, would select the lands which, upon the whole, are best adapted to this end. I perhaps would not put it so strongly as the chairman and say the lower slopes, but I would say, on the general principle which you have in mind, that this intermediate area, which combines volume of water and steepness of slope, is the most crucial and dangerous area, and it would be very greatly aggravated and might be worse farther down here were the forest removed.

The CHAIRMAN. And that area which you speak of as the crucial area is crucial right now because it has been cleared and is used as farming land?

Doctor VAN HISE. A part of it is crucial on that account, but there is a lower part that has not been cleared. These steeper slopes have not been cleared.

The CHAIRMAN. Oh, to be sure, there are places where the crucial slopes have not been cleared; but the ones we are speaking of now, those having the effect on streams—are those which are being used or have been used for farming purposes?

Doctor VAN HISE. Yes.

The CHAIRMAN. So, if we are going to take possession of them, we must dispossess men who are using them for farming purposes?

Doctor VAN HISE. I answer yes in every case in which land upon the whole is so badly located that it can not be maintained as a farm successfully, and is better adapted to forestry than to farming. That is the practice we have in Wisconsin. The commission goes to work there and we use our best judgment. We say, "Is this particular tract better adapted to agriculture or forestry?" and studying that particular tract, if we consider its soil, slope, and everything are better adapted to agriculture than to forestry, we sell it for agricultural purposes and use the money to buy land suitable for forestry purposes. On the other hand, if the land, by its location, by its character, is better adapted, upon the whole, to serve the State as forest than as farm, we change it into forest, even if it be a poor farm, and we are doing that thing now.

The CHAIRMAN. You can do that where the land does not belong to anybody who is making a home on it, but do you not apprehend a little difficulty in securing the land that you would have to acquire from people who have lived on it, and perhaps their fathers before them, for several generations?

Doctor VAN HISE. We do not pay any attention to that.

The CHAIRMAN. We are obliged to pay attention to it.

Doctor VAN HISE. It seems to me, of course, that the interests of the State and the nation are superior to those of the individual.

The CHAIRMAN. Pardon me. We must bear in mind all the time our responsibilities as legislators; and would you recommend that this committee favorably report any measure which, for its successful carrying forward, must take with it the authority of some government official to determine whether a given tract of land is more valuable for forest purposes than for farm purposes, and if he decides that it is more valuable for forest than for farm, give him the

authority, under eminent domain or some power of condemnation, to compel the owner of it to part with it?

Doctor VAN HISE. I answer yes to that, unqualifiedly.

Mr. STANLEY. Excuse me, Doctor, do you proceed upon the theory that the Federal Government would have the same right and has the same jurisdiction to take the land by a process of eminent domain, belonging to private individuals, on account of its better adaptability to forestry than to farming, that a state government would have?

Doctor VAN HISE. If necessary to protect the equable flow in the waterways, and therefore to protect navigation effectively and cheaply, and if necessary in order that the harbors shall not be filled up, if necessary for watershed for that purpose, then I say yes.

Mr. WEEKS. You speak of the State of Wisconsin purchasing land and setting it aside for forest purposes. Has the State expended any money for this purpose which has not been obtained from the sale of state lands?

Doctor VAN HISE. No large amount. We have a small appropriation which we can use for that purpose and can invest in tax lands, but we are going to ask a much larger amount for that purpose, and we have every reason to suppose we shall secure a larger amount, but our start was on the basis of the state lands going to the commission, with the power to sell and to buy, using the money which we obtained from selling to purchase.

Mr. WEEKS. Has there been a criticism of that process of procedure?

Doctor VAN HISE. Substantially none, because we have been extremely careful to dispose of the lands, which really are agricultural. We have tried to interpret that feature of the act fairly. If it was a very reasonably clear case that the land was really agricultural land, and a man said, "I want that land for agricultural purposes," and our experts showed it was really adapted to agriculture, we would advertise and sell it to him, even if it involved a special advertisement and sale.

(Thereupon, at 11.50 o'clock a. m., the committee took a recess until 1.30 o'clock p. m.)

COMMITTEE ON AGRICULTURE,
HOUSE OF REPRESENTATIVES,
Wednesday, December 9, 1908.

The committee met at 1.30 o'clock p. m., Hon. Charles F. Scott (chairman) presiding.

The CHAIRMAN. All the members of the committee are not here, but, as the record is printed, they will have access to it, and I do not wish to delay the hearing any longer. May we ask to have Doctor Van Hise take the stand again for a few moments only?

Governor GUILD. Possibly, to save a little time and answer some of the questions that have been put forward, it may be frankly admitted at once that the acquisition of forest reserves would dispossess some mountain farmers of their farms, but thereby not only is the infinitely greater number of farms lower down on the river, which would otherwise be sterile, rendered fertile by water, but thousands of times the number of people can be supported in cotton mills run by the water power thereby obtained than could be supported on the few farms which it might be necessary to have taken.

Then, in regard to the question of the form of mountains, I believe that matter is thoroughly discussed in the proceedings of the conservation commission, which will be available to you, and, as I understand this bill, it is a flexible bill, by which whatever portion of land that would be necessary might be taken, and in some instances it might be the extreme tops of the mountains and in others the intermediate slopes.

The CHAIRMAN. Governor, it is true, as you say, that the bill which was passed by the Senate is a flexible bill, and yet the reports which have come from the Forestry Bureau, and practically all of the arguments which have been made before this committee, have urged that it is the upper slopes of the mountains that need to be protected, leaving the inference, of course, that the lower slopes, which are now cleared off for farming, are not necessary to the success of this project. It rather seems to me, therefore, that if the fact should be developed that it is the lower slopes and not the upper slopes that are important to the project, our confidence in the judgment of those to whom we have looked for guidance in this matter must be severely shaken; and furthermore, if it should be developed that it is the lower slopes and not the upper slopes that must be safeguarded, it will be at once conceded that the cost of the project will be enormously increased. We have been urged to pass this measure upon the theory that because it is the inaccessible upper slopes that are needed we can get them cheaply, but we know that if it should prove to be the accessible lower slopes that are necessary, those can not be gotten cheaply, and, you see, it makes a vast difference.

Governor GUILD. I quite understand.

The CHAIRMAN. That was the point of my inquiry.

Governor GUILD. I quite understand it, sir, and it was a fair inquiry, unquestionably; but the point I wished to establish was, that it is practically impossible, as I understand it, to establish an absolutely hard and fast rule that in no cases must lower slopes be taken. Furthermore, one other point I wished to put in was in regard to the constitutionality which was put here, that eight Southern States and two Northern States, Maine and New Hampshire, have already passed enabling acts in regard to the right of eminent domain, by which the State practically invites the National Government to come into those States and exercise that right for the purpose of forest reserve.

Mr. POLLARD. Now, Governor, if that is the case, and there is a general disposition among the States that are covered by these mountain regions in question, why is it not just as feasible for the Government to come in and cooperate with those States and exercise the right of supervision instead of purchasing the land?

Governor GUILD. I would state that the governor of California, who has had some practical experience on just that point, will answer that question later.

Mr. POLLARD. It seems to me if we would have a cooperative arrangement between the Government and the States, or desire to cooperate, we might find a solution in that way and not purchase the land.

Governor GUILD. The first part of your proposition I think I have already answered, or at least I have tried to, by saying that the States are perfectly willing to cooperate, and are cooperating, and in our Commonwealth of Massachusetts, for example, where we are asking

for no reserve land, we are cooperating on the lower reaches of the rivers and spending our money to a certain extent; but, as I stated before, the State can not possibly out of its limited treasury be expected to provide for the large tract of land that would be required at the headwaters of the rivers.

Mr. POLLARD. I fully agree with you in that, but through a cooperative arrangement, the States being willing, could not the Government exercise the right of supervision in those States and obviate the necessity of purchase?

Governor GUILD. I do not think it would be possible, sir, to obviate the necessity of expenditure from the National Treasury.

Mr. POLLARD. You do not understand my question.

Governor GUILD. Possibly not.

Mr. POLLARD. I did not mean that the expense should all be shouldered upon the States. I meant that the Government should share its proportion; but to obviate the necessity of purchase, permit the forest lands to remain in the hands of the present owners and permit the Government to go in there and cooperate with the States, with their permission, which I understand would be necessary, and then we would exercise the right of supervision, the Government bearing a portion of the expense, or, so far as I am concerned, I would not object to its bearing all of it, and accomplish the same end, but obviate the necessity of purchase.

Governor GUILD. I do not think that could be obviated, sir. We have had practical experience in my own Commonwealth, and we have actually bought out of the state treasury tracts of forest lands and established them as reserves in the Commonwealth, and mere supervision of the land has not seemed to be possible. But if you will pardon me for a moment, sir, we were in the midst of some expert testimony, and I am afraid we are getting off the track.

Mr. POLLARD. The reason I asked the question was because it bore directly on your statement.

Governor GUILD. I thank you very much.

STATEMENT OF DR. C. R. VAN HISE—Continued.

The CHAIRMAN. Doctor, if you will permit me, I would be glad to ask you two or three more questions developing facts along the line we were discussing before the adjournment. When a slope has been cleared and farmed until it is so eroded as to become useless for farming, what becomes of it under present conditions?

Doctor VAN HISE. Under present conditions it does and would, in most humid areas, reclothe itself in time with vegetation, and finally with timber, but that frequently will not happen until the disintegrated material is practically all gone down into the streams and there has been very extensive wash. But in general it is true—I do not wish to in any way avoid the difficulties—that in these humid areas, if there is any soil left, they will reclothe themselves with vegetation.

Governor GUILD. After how many years? How long does it take?

Doctor VAN HISE. Of course it depends on whether you mean just the shrubbery or mean trees.

Governor GUILD. I mean trees.

Doctor VAN HISE. Of course many years for trees, and they have very much less favorable conditions than the first time because of the fact that they would have bare rock and a very scanty soil instead of abundant soil.

The CHAIRMAN. How long does it take to bring back the cover that will prevent erosion and retard a run-off.

Doctor VAN HISE. Usually, if there are no fires and if the streams are not too powerful, it will have begun to get a tangle of underbrush within five years.

The CHAIRMAN. I would like to say right there that I have seen a great many slopes where the erosion has been very bad that were completely reforested, so far as the creation of a cover to prevent further erosion was concerned, in much less than five years. Then there is an inevitable cycle, is there not, beginning with the forest and ending with the forest, with a little period of farming in between?

Doctor VAN HISE. There is where I should not accept the statement. There is an inevitable cycle if we take lands for agricultural purposes that never should have been taken for such purposes.

The CHAIRMAN. But we are assuming conditions to be as they are.

Doctor VAN HISE. But if lands are not taken for agricultural purposes which should not have been, there is not an inevitable cycle; there can be continual preservation of the disintegrated surface and continual forest cover.

The CHAIRMAN. Of course the point I have in mind is simply this: It has been brought out that the trouble we are now suffering has come from the clearing of the land for farming purposes and not from the lumbering operations.

Doctor VAN HISE. Partly from each, but more largely from farming.

The CHAIRMAN. More largely from farming.

Doctor VAN HISE. That is entirely true.

The CHAIRMAN. More largely from farming than from lumbering. That being true, it has occurred to some of us that the situation was one which carried its own remedy; that even if the lower slopes were cleared off, as they have been, when they become useless for farming purposes there is nothing the owner can do but abandon them, and when they are abandoned they are again covered, and we can not see what else the Government could do if it owned the land than to let nature take its course, just as it does now; for to go and artificially replant such areas would, of course, be prohibitive as to cost.

Doctor VAN HISE. If I might interrupt you right there—

The CHAIRMAN. It is no interruption.

Doctor VAN HISE. So far as these lands have been deforested, and so far as they have been applied to agricultural purposes when they should not have been, there is nothing to do but to get them back to forests as rapidly as we can by the best means we can, but there are very extensive areas in the southern mountains in which that process is now going on, and which will continue, and it will continue to go on and continue to dump this great quantity of material in the streams and in the harbors if you do not stop the deforestation, which should not be permitted. We can stop that present damage if we will. Great damage has been done. These areas have been deforested. There has been serious wash. These areas which never

should have been denuded of their forests ought to be restored to forests, and no more area similar to that should have the forest removed from it.

The CHAIRMAN. In a summary of data submitted for the use of the forest section in the National Conservation Commission, as you will remember, there occurs this statement:

The eastern mountain region lies east of the Prairie States, in which the planting of trees for the production of timber is of much more importance than for the production of stream flow or crops.

Do you concur in that?

Doctor VAN HISE. I would not concur in that for this southeastern part. It might be true, if that means the entire eastern part of the United States, east of the Rocky Mountains; that might possibly be true. But as applied to this southeastern area, which is under discussion, I would dissent from it altogether.

The CHAIRMAN. This statement also occurs in this same summary:

The Southern States contain about 12,000,000 acres upon which natural reproduction is insufficient or lacking, but upon which adequate fire protection will, in the main, restore good forest conditions—

And talking with citizens of North Carolina and Tennessee—and, I may say, very enthusiastic advocates of this project—they stated to me personally that they found it was altogether a question of fire; that if fire could be kept out of the Appalachian Mountains the slopes would never become sufficiently denuded to be a menace to the prosperity of the country. Do you agree with that statement?

Doctor VAN HISE. No; not that it would altogether. If you say that the factor of fire is an extremely important one on keeping this clothing, I say yes, but that it would be alone sufficient to keep the fire out, I would not agree to it, because the removal of these areas on these slopes which have never been made into forests is another factor, and out of that factor has come this great erosion, or if not the greatest erosion a very large part of it. Therefore this can be accomplished by a number of things. It can be accomplished by returning to forest these areas which should never have been cleared. It can be accomplished by retaining in forest those areas which are better adapted to the forest than for agricultural purposes, and those two together, combined with the prevention of fire, will solve the question. You must have the three—prevention of fire, retention as forests of those areas that are better adapted to forests than to agriculture, and restoration to forests of those areas which never ought to have been denuded of their timber.

The CHAIRMAN. One more question. Do you regard the statement which has been presented here showing the high and low water statistics for such rivers as of any scientific value?

Doctor VAN HISE. That general statement made by the forestry commission, of course, was a very large average statement.

The CHAIRMAN. The reason I questioned the value of the statement is because it covers so brief a period.

Doctor VAN HISE. It is a very general statement, but it so happens that, as to this particular southeastern problem, we have a much closer study of the Tennessee. It so happens that Mr. Leighton has given all his time for four months in studying the Tennessee particularly, and I have here this summary of the results. Mr. Leighton, if

the committee desires, can bring before you the evidence which shows the results, and in the case of the Tennessee, which I have gone over somewhat carefully, it seems to me it is a strictly scientific paper. It seems to me that the information he furnishes shows conclusively that in the past twelve years, as compared with the previous twelve years, floods have been more frequent in proportion to the number of flood-producing storms, and that is the point involved, by 18 per cent or thereabouts. This is the one stream, it so happens, upon which there has been a strictly scientific detailed study and analysis of the facts.

The CHAIRMAN. The theory, of course, is that the forest cover constitutes a sort of sponge that absorbs the water, and in that way prevents flood.

Doctor VAN HISE. Yes.

The CHAIRMAN. Is it not true that when this forest cover, this sponge, becomes thoroughly saturated any excess water immediately runs out?

Doctor VAN HISE. No; even then the excess water will gather in the needles and the leaves, and they will hold quite a lot of it.

The CHAIRMAN. For instance, if I had a slate here instead of this blotting paper, any water I dropped upon it would run off immediately?

Doctor VAN HISE. Yes.

The CHAIRMAN. I take this blotting paper and drop water upon it slowly, and no water runs off. I could continue that for quite a while. But suppose, first, that I immerse the blotting paper and saturate it thoroughly, then if I drop water on it would it not run off?

Doctor VAN HISE. It would run off slowly, and that is the great point. The average run-off is the same. There is no claim by us that there would not be the same average run-off if all the forest was watered, but what I say is that instead of that being made homogeneous, so that this is a stream free from sediment, it will be a vast torrent carrying down gravel and silt at flood time, and there will be practically no stream at the other times of the year. So that this flat surface is to equalize the flow, and so make it valuable for water power—more valuable for water power than for navigation, and so forth.

The CHAIRMAN. I realize that an ordinary rainfall would be absorbed by the humus and would be given out slowly later on, but every flood comes from an excessive rainfall?

Doctor VAN HISE. Yes.

The CHAIRMAN. Otherwise there would not be any flood. When that condition occurs, when your humus is absolutely saturated, is it not true that if the rain keeps on falling there will be a flood? And is it not true that we have had floods in the rivers from time immemorial? Is it not true in Oregon and in Washington that some of the severest floods that have ever occurred have come while the forest cover was perfect?

Doctor VAN HISE. It is entirely true that if the rain is so excessive, if there is a flood-producing rain away beyond the capacity of the forest to absorb it, that even with a virgin forest we still may have a disastrous flood, although it will not be usually so silt laden a flood

as under these circumstances; but the point I hold, and it seems to me Mr. Leighton in his report clearly shows, is that the same number of flood-producing rains under conditions of the removal of the forests produce more floods than what would occur were the forests kept there, and the rapidly increasing percentage, 18 per cent in the last twelve years, as compared with the previous twelve years, due to the difference in denudation.

The CHAIRMAN. Are you familiar with a paper written by Col. H. M. Chittenden and read before the American Society of Civil Engineers?

Doctor VAN HISE. No; I am not. I have heard of it, but I have never seen it.

The CHAIRMAN. Colonel Chittenden has been studying this question for twenty or thirty years.

Governor GUILD. If you will pardon me at this moment, Mr. Swain is very familiar with that, and if perhaps Doctor Van Hise is not familiar with it, we had better let the expert who is familiar with it answer your questions in regard to it.

Mr. WEEKS. The floods are not all produced by excessive rains. In the snow regions the floods are produced by excessive melting of the snow?

Doctor VAN HISE. Yes; causing an excessive flow of water. In snow areas, where there are heavy snowfalls, that is a factor. I have not said very much about that, because it is not a very important factor in reference to these southern mountains.

Mr. WEEKS. It would be a factor in the White Mountains?

Doctor VAN HISE. Yes; it is a very important factor in the White Mountains.

The CHAIRMAN. Would you believe it to be true that a heavily forested watershed in a northern latitude, like New Hampshire, might give a result of more disastrous floods than an open watershed?

Doctor VAN HISE. Do you mean the one that is not timbered?

The CHAIRMAN. The one that is not heavily timbered.

Doctor VAN HISE. I would say, as far as the facts are analyzed it bears the other way; that even where there are snow areas the number of floods is less. Although no one stream is accurately analyzed in the same way that the Tennessee is analyzed, yet these tables show that the same thing has occurred, taking the evidence as a whole.

The CHAIRMAN. As a matter of pure reasoning, we know that in a heavily timbered watershed the wind is broken and the snow falls practically on a level all the way through, and by the shade of the trees it is held there a long time, until the air becomes warm. Then the warm rains come along and wash it all away at once.

Doctor VAN HISE. That is comparatively rare.

The CHAIRMAN. Does it not happen every winter and every spring?

Doctor VAN HISE. The rain has to be a very long-continued and abundant rain. One of the greatest floods described by John Muir occurred under those conditions. That is a possibility; it is not only a possibility, but it actually occurs. But on the whole the precipitation in the form of snow serves to equalize the flow. In the region of the Rocky Mountains, and also in the great valleys of California, it is a maxim: "There is a good snowfall; we will have a good year for irrigation."

The CHAIRMAN. That is, the unprotected slopes of mountains allow the snow to be piled in the canyons?

Doctor VAN HISE. And the trees produce the same effect exactly as the canyons.

Mr. WEEKS. As a matter of fact the White Mountain region is not entirely wooded; there are open spaces and then wooded spaces.

Doctor VAN HISE. Rocky spaces.

Mr. WEEKS. If you are familiar with that section you know that very often the snow is entirely melted away in the open spaces when it may be a foot or two deep in the wooded spaces. Therefore if the timber or wood had been cut off in those wooded places it would have all gone off at the same time and produced much more water at one time than is produced under present conditions?

Doctor VAN HISE. Exactly. May I make one statement? I have tried to answer these questions specifically and concretely without giving their qualifications and modifications. So, in fairness to myself, I think I ought to be permitted to make one qualifying statement. I was asked the question if I were allowed to select an area, and if I could only have one, which would I select? I said under those circumstances the lower part of the steeper slopes would probably be the most important. However, I would not desire the committee to conclude therefore that I do not believe it is necessary to conserve these steep upslopes to the flat tops, because they are the great sponge which holds this water and allows it to come down through springs and equalize the flow. That is to say, if you should remove this top area, supposing this is one of the regions, there would be destructive wash and floods here which would carry the material down. It seems to me that the only safe procedure, the only possible procedure in the Southern Appalachians, with reference to the good of the Nation, is for the Nation and the States and individuals by some system of co-operation to conserve practically all the slopes which are steeper than those which should be used for agricultural purposes.

Mr. WEEKS. In the final analysis, in this last statement you have made, you would be governed by the specific conditions surrounding each case?

Doctor VAN HISE. I would be so governed precisely, if you ask me what I should do provided I had the money and could go down there and do it. In making a careful survey of all the States my idea would be to pick out the steep slopes in which there had been some forest removed, perhaps. I would get the headwaters of the streams, and take here a bunch and there a bunch of, say, 25,000 or 50,000 acres, where the injury is the greatest and the destruction is the greatest, and use those as areas, not only to stop the wash and to stop the flow, but to serve as educational areas for individuals and States both.

Mr. POLLARD. This proposition, then, resolves itself ultimately in the purchase by the Government, or the bringing under the control of the Government practically all of that area—that is, the upper regions, as well as the lower regions—if the success of the project is complete; is that not true?

Doctor VAN HISE. Yes. "Complete" is a perfect word, you know. That is true, before all this destruction is stopped; yes.

Mr. POLLARD. Then, of course, the report sent to the committee by the Secretary of Agriculture, in which he says that 5,000,000 acres would suffice, is merely a beginning, and before we got through we

would have to bring under the control of the Government, or purchase by the Government, practically all of the 75,000,000 acres that is described in that report?

Doctor VAN HISE. No; I do not agree to that statement, for this reason: I have had the experience myself with the great power of example in educational influence, and I have had to do with trying to get States to cooperate in this very problem—Wisconsin, Michigan, and Minnesota—and we have made great progress up there, and have had a demonstration lesson. The action of Wisconsin has been of great help in getting Minnesota and Michigan to move in the same direction, and I think, as I stated at the outset, that this is so large a movement that the Government, being vitally interested in the waterways, vitally interested in the harbors, ought to do what it can. Then the States can go forward and do what they can, and the Government and the States must cooperate with reference to fire patrol, and then public pressure must make the individuals feel their public responsibility and make them handle their holdings as public trusts.

Mr. POLLARD. Granting all that to be true, must we not banish all hope that this can be accomplished by the purchase of 5,000,000 acres in the Southern Appalachians?

Doctor VAN HISE. If you mean that the purchase of 5,000,000 acres in the Southern Appalachians will prevent altogether this destructive wash, it is wholly inadequate. However, I have no doubt that with the purchase of 5,000,000 acres to serve as examples to Virginia, North Carolina, Tennessee, Georgia, and Alabama we will get those States to go to work and do their part, and it will bring pressure on individuals to do their part.

Mr. POLLARD. Then I understand that your idea is that if the Government purchases these 5,000,000 acres in blocks, that that will encourage the States to come in and buy other parts?

Doctor VAN HISE. My hope is that; yes.

Mr. POLLARD. My understanding was that it was a mammoth undertaking. We have been lead to believe that the 5,000,000 acres was sufficient, and we have labored under the impression that we should simply take care of these upper watersheds. Now it seems to be developed that it is of greater importance to protect the intermediate sheds and a portion of the lower sheds. This report of the Secretary, where it refers to the 5,000,000 acres, simply covers the upper sheds, so that these intermediate slopes and the lower slopes are not taken into account at all in his estimate of 5,000,000 acres.

Doctor VAN HISE. I confess a lack of familiarity with the details and recommendations of the Secretary of Agriculture, and I did not understand that there were any definite lands recommended. I understood that if there was money appropriated for the purchase of the 5,000,000 acres experts would go and find out where they had best be purchased, leaving them free to select the most pressing and crucial areas, which will, on the whole, do the most good in the way of educating the States and individuals in the way of preventing erosion. I fear that I have taken too much time.

The CHAIRMAN. It was at our request, and we are very much obliged to you. Governor, will you allow me to ask you a question before you introduce anyone else?

Governor GUILD. Most certainly.

The CHAIRMAN. Because I know you have considered this from a broad standpoint.

Governor GUILD. I have tried to.

The CHAIRMAN. You have heard Doctor Van Hise express the opinion that what the Government might do would be to go into these States and buy tracts of from 25,000 to 50,000 acres as a sort of object lesson to the people?

Governor GUILD. Yes.

The CHAIRMAN. Have you ever taken into consideration the view that would be held locally upon the proposition of taking that much property off the local tax rolls—what might happen to some one county, perhaps, where 50,000 acres were thus sequestered?

Governor GUILD. Most certainly. Although it might take a certain amount off a local tax roll, it would add so much to the land in the other place, which would thereby be improved by the water supply and by water power that the one would much more than offset the other, we think.

The CHAIRMAN. Do you not think that the parties whose assessment was increased would think it was rather unfair that in order that the Government could have this property for reservation they would have to pay more taxes?

Governor GUILD. I think the best answer to the local opposition of States to which you refer is that 8 Southern States and 2 Northern States have already requested that the thing be done.

The CHAIRMAN. I am perfectly aware of that, but I was wondering whether it had been specifically considered.

Mr. HAWLEY. Was it not stated before us last year that the Government would be expected to share the profits of these forests with those States, or find some other way to compensate them?

Governor GUILD. I was unfortunately unable to be present at the hearing of last year, much as I desire to be here, but Mr. Ayers understands that phase of the question and has been present at all the hearings, and I will call upon him, if you please, the state forester of New Hampshire.

STATEMENT OF PHILIP W. AYERS, STATE FORESTER OF NEW HAMPSHIRE.

Mr. AYERS. I merely desire to answer the point raised by the chairman, that the bill which passed the Senate proposes that these reserves in the eastern mountains, if established, shall be conducted in exactly the same way as the western reserves. I think it has been decided by the Forest Service to be a fact that the western reserves turned back the portion of the incomes in which those counties are located.

The CHAIRMAN. You understand that it further developed in these hearings that the price of lands now having workable timber upon them would be so high that nobody would advocate their purchase, including the timber, and that the best that could be expected would be that we could buy the land with the privilege to the owner of removing the merchantable timber. That being true, of course we could not expect to get any revenue until the second growth became available, so that there would be a period of from five to one hundred years before a return could be possible.

Mr. AYERS. If the governor will permit me, as far as the White Mountains are concerned—and I am familiar with the White Mountains—there are various kinds of land which would necessarily be giving a return, even in a small tract of 25,000 acres. Being the forester for Dartmouth College and having under my personal charge a tract of 26,000 acres, I know that even though that has been cut over, we are able to get an annual revenue of from ten to fifteen thousand dollars from that particular cut-over forest. That is exactly what we want to do in other places of the White Mountains. If you take a tract as large as 25,000 acres already, there is certain to be mature timber, and a certain part of that revenue will go to the county.

The CHAIRMAN. Can you give us an idea of the price that land containing that timber could be bought for?

Mr. AYRES. Land in the White Mountains can be had, according to the degree to which it is cut over, some more and some less, from \$1 to \$20 per acre.

Governor GUILD. Before going further with the hearing, of course it is thoroughly understood that the committee is seeking for information, and therefore, of course, the examination of our expert witnesses has become a necessity. We recognize that, but unfortunately it is a fact that thereby a number of prominent representatives of the various States may be prevented from testifying at all, and I should like to state, as a part of the record, with your permission, that we expected to have introduced this morning, as sympathizing with and behind this movement and asking for its adoption, Governor Hoke Smith, of Georgia; Governor Martin F. Ansel, of South Carolina; Governor Rollin S. Woodruff, of Connecticut; Governor N. C. Blanchard, of Louisiana; Governor John A. Johnson, of Minnesota, and President George E. Barstow, of the National Irrigation Congress. These gentlemen were all ready to speak this morning. Whether it will be possible for them to come here this afternoon I do not know, but I am sure you will not object to having the list of their names.

The CHAIRMAN. The committee will take official notice that those gentlemen would have favored this measure if they could have appeared before us.

Governor GUILD. Governor Pardee, of California, is here, and I shall call upon him next for a few words.

STATEMENT OF HON. GEORGE C. PARDEE, EX-GOVERNOR OF CALIFORNIA.

Governor PARDEE. Understand, Mr. Chairman and gentlemen of the committee, that my name will be entered in this distinguished list, not because it is distinguished, but because I am here. I wish to add this to what has already been said: I know of no way by which government supervision, be it state or national, of privately owned lands can be effectively carried out along the lines for which this bill provides in all cases. If the forests be taken when they are in their prime and before they have been cut and burned over and the police power of the States first, and then, if necessary, of the nation thereafter, be invoked to preserve them, a supervision without public ownership might, and probably would, be sufficient, but there are many places in my own State, and I apprehend the same thing applies to the Appalachian and also to the White Mountain regions,

where the state of affairs has gone beyond that, and in those cases I have no doubt in the world that there should be public ownership; whether of the States or of the nation is a question to be decided by the relative powers of the two governments, state and national, to acquire those tracts of land. My own State has done something, other States are doing more, toward that end. But I apprehend that you, Mr. Chairman and gentlemen of this committee, will agree with me when I say that it is more than a state issue. It is a question which applies in the Appalachians, to California, and Oregon. I believe thoroughly and heartily, gentleman of the committee, in the question of cooperation as between the individual States and the nation, but there are certain occasions, and I believe that those have been arising in the Appalachians and also in the White Mountains—I know they have arisen in my own State—where it is not a question of cooperation between the Government and the private ownership, but public ownership, either of the State or of the nation, shall be acquired.

Mr. POLLARD. Will you describe those conditions, Governor?

Governor PARDEE. Where the forests have been cut and burned extensively, where great waste is going on, where the streams have filled up, where the harbors at the mouths of those streams are filling up and have filled up, then the strong arm of the Government should come in, either of the State or of the nation, and take charge of that affair and see that it is absolutely stopped.

Mr. POLLARD. May I ask you a question?

Governor PARDEE. A dozen.

Mr. POLLARD. I take it, Governor, that all of those who favor the preservation of these forests are not so much concerned about the means as about the end. It is the end that we are seeking to attain. That is, we want to accomplish the preservation of the forests and the uniformity of the stream flow, rather than to be wedded to any particular method.

Governor PARDEE. Yes, sir.

Mr. POLLARD. It is the end.

Now, then, this committee has been led to believe that the only manner by which the Government can either supervise or purchase the desired land is under that provision of the Constitution which gives Congress jurisdiction over commerce, and the Judiciary Committee holds that the only lands that we could buy, even if we want to go out to purchase lands, would be those lands that had a direct bearing on navigation, and that other lands were out of the question. I am not a lawyer, and it does not matter to me whether you and I agree to that or not, but that is the opinion they have handed down. Inquiry develops, to my mind at any rate, this fact, that if the Government can go and buy a tract of land for the purpose of aiding navigation by the preservation of the forests on the rivers, it can also go in under the same constitutional power and regulate the manner in which the private owners shall control that land, so far as it has a bearing on navigation, and that the same constitutional authority gives the right to do one as it does to do the other. Why can not the Government, if that be true, exercise a supervision over such a tract of land as you have described, just as well if it bears on navigation in one case as the other?

Governor PARDEE. Would that not, in very many cases, be practical confiscation?

Mr. POLLARD. The bill to which I refer provides for payment in such cases.

Governor PARDEE. Then, practically, the Government is buying the land.

Mr. POLLARD. If the damages cover the value of the land, yes.

Governor PARDEE. And it must, in those cases, because otherwise the land can not be used for any purpose to which the owner has been in the custom of using the land, and therefore it is confiscation.

Mr. POLLARD. In that case the Government would have to pay for it.

Governor PARDEE. Which is a practical purchase by the Government of the land.

Mr. POLLARD. Practically so.

Governor PARDEE. I have no doubt in the world but what there should be the cooperation, but speaking with due humility for my own State, the State of California, and I presume that other States are in the same condition, especially the newer States are very slow to move in those matters; but it is for the benefit of the Eastern States that the State of California shall take up those matters, and if the State will not take it up the Government itself shall take it up.

Mr. POLLARD. What objection would there be to a plan like this: For the Forestry Department of the Government, under the direction of the President, to make a survey of the forest land, say, in the Southern Appalachians and the White Mountains—those are the mountains in question here—and determine what portions of them should be preserved as forest reserves, and then, by proclamation, to bring them under the supervision of the department? Then the Government goes out to supervise those lands. The question at once arises as to whether they have a bearing on navigation, and if it is so held, under the decisions of the Supreme Court, I think the Government has the right to regulate those lands without any question, just as much as they have the right to purchase them in the first place.

Governor PARDEE. Undoubtedly.

Mr. POLLARD. Why would not a plan of that kind reach the object, accomplish the object we are seeking to accomplish, and obviate the necessity of purchase?

Governor PARDEE. It would not accomplish all we have to reach, for the reason that down in the lowest parts there is land that is in deep trouble, land that is being denuded of its soil, having been already denuded of its vegetation.

Mr. POLLARD. Would that not come under the terms of the law, if it were shown that it interfered with navigation?

Governor PARDEE. Then, would the United States go in and spend money on private property?

Mr. POLLARD. It would not spend any money there.

Governor PARDEE. Then how could it regulate it?

Mr. POLLARD. It would simply prevent the owner from using the land in such a way as to excite this erosion.

Governor PARDEE. Therefore take his right of living on the proceeds of that land away from him and leave him to starve. Confiscation, it seems to me, is the absolute result of that proposition carried to that end under those conditions.

Mr. POLLARD. The terms of this bill provide that in such cases he will be reimbursed.

Governor PARDEE. Then the Government purchases the land. [Applause.] I have no quarrel at all with the proposition that the Government can, under the case decided by the supreme court of Maine, regulate the use of land that is forested and in good condition, and it is not taking the land away from the owner. I am no lawyer, by the way, and I sympathize with you heartily on that. The owner may still, under the supervision of the State or the Government, use the land for the purpose for which it is intended—that is, forestry—and for which he is using it, but he may not denude that land.

Mr. POLLARD. That is true.

Governor PARDEE. This land down in the Appalachians, a good deal of it, as I am told—I have never been there, but I am so told, and I believe that is admitted—is already denuded of its forests; that land is not primarily agricultural land of the best kind and quality, and that it has been so used, and that it has not only been denuded of its forests and vegetation, but is now being, and a great deal of it has been, denuded of its soil. Now, to say to those people who have denuded it of its forests for agricultural purposes, and because of the agricultural use of the land it is being denuded of its soil, that they shall not use that land for agricultural purposes, is, with due deference, confiscation, and the only thing left for the Government is to step in and buy the land.

Mr. POLLARD. Granting that to be true, and I am inclined to agree with you, would it not be just as well to have a general system of supervision, which you admit, as I understand, would apply to most cases excepting instances such as you have just described? Then we would not purchase any of the land, would exercise supervision over all that where it is only partially, say, removed—partially denuded, I should say—and the Government then would only purchase, by condemnation proceedings, as you have described, those tracts that are wholly denuded and ought to be brought back into forest condition.

Governor PARDEE. Except those slopes of the forest land, and I am told that very large tracts of such exist, where any cutting of the timber would lead to its denudation, not only of the vegetation of the forest growing upon it, but also of the soil itself, there the Government, in justice to the owners of it, must go in and buy in order to preserve the status quo. Otherwise we simply say to the man that he may own the land and derive no benefits from it; must pay taxes on it, but can not use it for the purposes for which he bought it. Therefore, to my notion, there is a manner given for the Government to act under those circumstances—the government of either the State or the nation—to buy that land and use it for the purpose for which nature designed it to be used, and for which the Government of the United States desires it to be used, as a protection for the rivers, the streams, the harbors.

Mr. POLLARD. Under a plan where the Government went in there under supervision and prevented the cutting of anything but matured timber?

Governor PARDEE. I am told that there are some places there where even the cutting of the matured timber would make trouble. I am also told that a great area of that country has already been cut and is being cut at a very rapid rate.

The CHAIRMAN. Will you permit me to suggest right there that I think that is an exaggeration of the existing conditions? Of course, I do not mean to say that I have traveled all over the Southern Appalachians, but I did spend a week in a part of North Carolina, where I was advised to go by a very enthusiastic advocate of this project, because it was stated that the worst conditions resulting from the denudation of the forests were to be found there that could be found anywhere. I think it would be conservative to say that not to exceed 10 per cent of the total area of the mountain sides was devoted to farming—denuded.

Governor PARDEE. I know nothing of that at all.

The CHAIRMAN. I merely wanted to have that statement go in, because I think it was conveying the wrong impression to give out the idea that a great proportion of the country is denuded.

Governor PARDEE. Would you permit me to call your attention again to a statement made by Doctor Van Hise, which struck me as the meat of this whole proposition—that there are great areas of that country which never should have been and never should be put to agricultural purposes, and that those properties are the 10 per cent which have already been put there, and that the other 90 per cent of those districts should never be put to agricultural uses.

The CHAIRMAN. I saw the slopes in North Carolina, which, coming from the Kansas, where our land lies as it should lie, I should have said ought never to have been devoted to farming, and yet it belonged to men who said that they would not part with it for less than \$20 an acre, because they were raising crops on it every year.

Governor PARDEE. No doubt.

The CHAIRMAN. And therefore it might become a serious question as to whose judgment should determine.

Governor PARDEE. Finally, Mr. Chairman, experientia has doceted me [laughter] that finally you must come to the expert and take his views; that the blacksmith must shoe the horse best; he may now and then lame a horse, but he can shoe the horse best. I have been dragged a little away from my proposition, which was simply this, that where cooperation is possible, and in a great many cases it is, that that is the thing; that where the States will not or can not or do not do as they should do in those matters, then the Government of the United States, in defense of itself and in defense of its people, should step in; that where necessary purchases should be made by the State, where the thing can be regulated by the State or, if necessary, finally by the Government, and where that regulation is itself sufficient, then regulation is enough. But that no purchases should be made, speaking from the standpoint of the Californian, I deny. [Applause.]

Mr. HAWLEY. Was that case you referred to from Maine a decision on the case, or was it an advisory opinion handed down by the court to the legislature?

Governor PARDEE. It was an advisory opinion.

STATEMENT OF HON. FRANK D. CURRIER, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW HAMPSHIRE.

Mr. CURRIER. Mr. Chairman, I wish very briefly to present some facts bearing on the question of whether the removal of forests from the mountains affects in a material way the uniform flow of navi-

gable streams in the East. For twenty years the Government has been conducting stream measurements at Plymouth, on the Pemigewasset River, which is a main branch of the Merrimac, and I have here a chart made for me by the Geological Survey showing the result of those measurements, and, by the way, the measurements began in 1886 and cover the twenty-year period down to 1906. It was about that time that the great cuttings began in the White Mountains, particularly on the southern slopes, the Pemigewasset rising on the southern slopes of the mountains. You will see from that chart, Mr. Chairman, that the low-water period has increased from nine hundred days in a ten-year period to one thousand three hundred days, or four hundred days in a ten-year period, running up sharply from the nine hundred period to the thirteen hundred, while the rainfall has remained almost the same, this line here indicating the rainfall. This chart states the persistency of low-water stages on the Pemigewasset River by progressive ten-year periods, showing number of days in each period from 1886 to 1906 that gauge at Plymouth, N. H., registered 2.5 feet and below. Also corresponding mean annual rainfall for progressive ten-year periods. The chart gives striking evidence, it seems to me, of the effect of removing the forests from the White Mountain region, for that was about the time the cuttings on that slope began. I wish each member of the committee would look at this chart, and I file it as one of the exhibits. I do not know how it may be in the Southern Appalachians, but all we need protected are the high, steep slopes in the White Mountain country. All the rest will reforest itself. It is only on the high slopes, when the forest is taken off, the soil is all washed away down to the bare granite rock.

The CHAIRMAN. Does that extend all the way to the bottom of the mountain?

Mr. CURRIER. No; it is only on the high, steep slopes.

The CHAIRMAN. When the lower part of the mountain is reforested, does it not serve as a sort of retarder?

Mr. CURRIER. Not if you have a mile and a half of bare rock above you, where every drop of rain will run off in thirty minutes.

Mr. WEEKS. You should have used the words "burned away."

Mr. CURRIER. Yes; burned away, because the fire burns off the growths in the burned-over areas. The fires that come from cut-over lands extend into the virgin growth, but it is rarely indeed that a fire starts in the virgin growth. But what we need is protection for the timber land for the higher slopes that never can reforest themselves.

The CHAIRMAN. Is it, in your judgment, a question of fire protection, largely?

Mr. CURRIER. No; fire is a very important factor in it. Fire starts in your cut-over lands, started by hunters in the fall. As the hunting season opens early, the timber is dry, and the fire starts and gets under tremendous headway in those cut-over lands, but I scarcely ever heard of a fire starting in a virgin growth.

Mr. HAWLEY. Did I understand that you had continuous slopes a mile and a half long in the White Mountains?

Mr. CURRIER. I think so.

The CHAIRMAN. Has New Hampshire any fire patrol?

Mr. CURRIER. Not any. I do not know, but apparently there has been an intimation that New Hampshire ought to have gone ahead and established this reserve. It is too great a work for this little State, and I want to state that four New England States are more interested in that question than New Hampshire is. Substantially every river of any consequence in New England rises right there in the White Mountains, and those rivers flow into every New England State except Rhode Island. Take the Connecticut in four of them. The Merrimac supports two great cities in Massachusetts that would be flag stations on the railroad if it was not for the water of that river—Lowell and Lawrence. The Saco, that rises in the White Mountains, is not utilized at all in New Hampshire. The Androscoggin is used at only one point and passes on into Maine. They support great cities, and the Connecticut, that flows between New Hampshire and Vermont, across the Massachusetts line, is not utilized by the State of New Hampshire. Every manufacturing plant on the Connecticut opposite New Hampshire is located in Vermont.

The CHAIRMAN. Of course we can not take the question of water power in the stream.

Mr. CURRIER. I am talking about navigation, not about water power, although I take it that it would not be an objection in the minds of this committee that it would serve to give employment to tens of thousands of people if you could do that as an incident.

The CHAIRMAN. Undoubtedly not. But may I ask you this question, whether any data has been prepared showing to what extent the water power has been diminished?

Mr. CURRIER. I just presented it to you, four hundred days in a ten-year period, four hundred days more of low water than there was ten years ago.

The CHAIRMAN. That might be true and yet the water might not be low enough to result in a loss of power.

Mr. CURRIER. Even now we have to have an auxiliary steam plant and machinery, and if we undertake to run with steam alone, with coal as high as it is, we would close our plants; and all along those rivers the leading industries have auxiliary steam plants.

The CHAIRMAN. Have any data ever been prepared showing the difference in actual horsepower of the water power developed now and developed in a similar period?

Mr. CURRIER. No; I would think not; except that when you have got what they call the low-water period at Plymouth, you may be sure that the water is not furnishing much power at the manufacturing cities of Manchester, Lowell, and Lawrence, and that period has increased forty days in a year. Pardon me if I make one suggestion as to Mr. Pollard's proposition about the government regulation. The lands we need to acquire can not be gotten under government supervision or regulation. When you get lands on the high slopes in New England, you have got to get every single thing. You go in there and thin out your matured trees, and the next winter the wind will bring down all those left.

The CHAIRMAN. How do they ever get to be big, then?

Mr. CURRIER. Because they have grown up almost a solid mass. You go in there and take out half the trees. No one has ever seen a New England forest cleared out but that he finds on the high slopes that the trees are blown down.

Mr. POLLARD. Is that on account of the shallowness of the soil?

Mr. CURRIER. Principally that; a great many of the trees have been simply turned over. I do not know that I have anything more to say.

Mr. HASKINS. Is it the lumber interests of the White Mountains or the farming interests that have denuded the lands?

Mr. CURRIER. The lumber interests.

Mr. HASKINS. Entirely so?

Mr. CURRIER. The lumber interests. The chairman was speaking about the floods caused by the snows going off. What my friend, Mr. Weeks, said about that is true. Half those lands, or great patches everywhere, are cleared. I live in the mountains at home. Half of the country about me is forest, and from the other half the snow goes off before the snows in the forests move at all. We never have freshets when we have a heavy snowfall. When we have 3 or 4 feet of snow in the woods we never look for freshets, because that amount of snow will stand a thirty-six hour rain before it will let out a drop. We look for freshets when we have 5 or 6 inches of snow; that is, in the fall, when it all goes off with a warm rain.

The CHAIRMAN. I notice the statement, which is attributed to Mr. Ayers, to this effect: "The farms in the Connecticut Valley are among the richest in the State, that is, in New Hampshire, and have been less abandoned than elsewhere. There is, however, a goodly acreage, amounting to 25 per cent, which was cleared land in 1850 and which has reverted to forests, much of it good white pine forests." And I have seen elsewhere that the watershed of the Connecticut River above Holyoke is very much better forested now than it was forty years ago.

Mr. CURRIER. All through my own section, which is about halfway up the State, in the Connecticut Valley, we have more forests than we had fifty years ago. I want to say another thing. It has been suggested that the diminution of stream flow has been largely caused by drainage in clearing the lands. I want to say that that does not apply to the Pemigewasset at Plymouth. All along this river there is less tillage land than there was fifty years ago, and more woodland.

The CHAIRMAN. How do you square that with the argument that it is the denudation of all the woodland that creates the floods?

Mr. CURRIER. The denudation is at the head of these streams around the White Mountains, where this enormous cutting is taking place. [Applause.] We are not asking the Government to buy any lands down in the low hills and the flat country. That will reforest itself; it does it with marvelous quickness. My own section is a white-pine section. I have a neighbor who three times in his life-time has cut over his pine lands completely.

Mr. HAWLEY. How large would the trees be?

Mr. CURRIER. Forty thousand feet to the acre, board measure.

The CHAIRMAN. When you speak of the watershed of a river, I at least get the idea that you mean the entire watershed.

Mr. CURRIER. I did not mean the entire watershed.

The CHAIRMAN. But when you say that the watershed is better forested now than it was fifty years ago, it would really seem to me that we ought to find out what relation that has to the flow.

Mr. CURRIER. Not the lower reaches of the river, but the reaches of the river as it comes out of the mountains. If you could see the

slopes of the White Mountains yourself, any of you gentlemen, some of them with a stupendous growth and others cut as clean as Mr. Hale described it to-day, you would realize that those snows, all left open to the sun, going off rapidly, and with the rains coming down on it and the soil being washed on the upper slopes, leaving bare granite; every drop of water runs off.

The CHAIRMAN. If the denudation there results in bare granite and has resulted already in bare granite, and if you can not raise a little tree without the protection of larger trees, what would you have the Government do in case it purchased that?

Mr. CURRIER. Those slopes that have not been cut over have not a very valuable growth on the upper slopes; the prices are small. There is a growth there which is worth cutting now if those lands could be purchased. Under those operations the soil itself all washes away, and nothing can be done. The mountains that have been cut over in my State, which are more than 3,000 feet high, have got now from 500 to 1,000 feet down to bare rock, and they used to be covered over the summit with trees.

Mr. POLLARD. What would be the cost of this land which you spoke of a moment ago that you want the Government to purchase?

Mr. CURRIER. It is difficult to lumber there, and they are short-bodied trees, as they call them. I could not tell you the cost; but they are not particularly valuable; nothing like the value of the great pine growths of the lower slopes.

Mr. POLLARD. Could you approximate it?

Mr. CURRIER. No.

The CHAIRMAN. Do you think the upper slopes, which you described as bare granite, should be purchased in any scheme of this kind?

Mr. CURRIER. Possibly not; but I would purchase clear up to the timber line. Nobody expects you to purchase the top of Mount Washington. The bare rock up there is worth \$3,000 or \$4,000. Nobody wants that purchased; but purchase as high up as the timber goes.

The CHAIRMAN. I would like to suggest to the gentlemen here, we do not want to give the wrong impression. The questions that are being asked by the chairman and the gentlemen of the committee are asked for the purpose of eliciting information. They are asked to meet objections we hear on every hand.

Mr. CURRIER. Any information I can possibly give, you know I will.

The CHAIRMAN. You will understand, I know, Mr. Currier; I want the rest of the gentlemen to understand that any question is not asked as a question of objection or controversy, but in absolute good faith. [Applause.]

Mr. HAWLEY. As to the matter of forest reproduction, that was a matter in which we are greatly interested. I asked a question a moment ago, and I have been figuring. If I understood you correctly, you said that one man, in his lifetime, had cut over his land three times.

Mr. CURRIER. White-pine growth.

Mr. HAWLEY. At the average of about 40,000 feet to the acre?

Mr. CURRIER. Yes.

Mr. HAWLEY. That would be 120,000 produced on 1 acre of land in a man's lifetime?

Mr. CURRIER. Yes.

Mr. HAWLEY. Or about 20,000,000 feet in a quarter section?

Mr. CURRIER. Yes.

Mr. HAWLEY. That is a remarkable reproduction of timber.

Mr. AYERS. That is not in the mountains.

Mr. HAWLEY. Anywhere.

Mr. CURRIER. There is no pine after you get up 2,000 or 3,000 feet.

Governor GUILD. Are those lands in that part of New Hampshire in which it is contemplated to purchase forests?

Mr. CURRIER. No.

Governor GUILD. Then that does not enter into this subject, does it?

Mr. CURRIER. No; he was speaking about the reforestation of the low slopes.

Governor GUILD. Exactly; but we are talking to this particular proposition.

Mr. WEEKS. Conditions are very different in the White Mountains from what they are in the Southern Appalachians?

Mr. CURRIER. Very much.

Mr. WEEKS. The lands that you propose to purchase in the White Mountains are those lands where the soil is very thin, and where if the timber is once cut off and the fire gets in it burns everything as clean as the walls of this room and it is impossible to do anything with that in the future. That is what you want to buy. The fact is, probably, that there is more wooded territory in New Hampshire than there was fifty years ago, taking the whole State.

Mr. CURRIER. I have no doubt of it.

Mr. WEEKS. But that is not true around the headwaters of these rivers?

Mr. CURRIER. Not at all. Fifty years ago it was an absolutely virgin growth.

Mr. WEEKS. And what you want to buy in the White Mountains are those slopes which have not been cut off yet; and if they are once cut off will leave a bare surface that will precipitate all the moisture that strikes them in a short time?

Mr. CURRIER. Just that, Mr. Weeks.

Mr. HAWLEY. How large would a tree be that this man would get off this land? How many inches through at the point of cutting would it be?

Mr. CURRIER. I suppose 14 to 18 inches.

Mr. HAWLEY. And that would be reproduced three times in the lifetime of the man?

Mr. CURRIER. This old man, 83 or 84 years old, told me last winter that for the third time in his lifetime he cut over his land.

The CHAIRMAN. As I understand it, then, the problem in the White Mountains is not the protection of the lower slopes, because they protect themselves, and it is not the purchase of the upper slopes that are now denuded?

Mr. CURRIER. It is not like the Southern Appalachians.

The CHAIRMAN. Let me finish my statement. It is not the purchase of the upper slopes that are already denuded, because they can not be reforested. It is the purchase of upper slopes that have not been cut over in order that they may be protected?

Mr. CURRIER. That is just it.

The CHAIRMAN. I believe you said a moment ago that you did not believe the situation could be taken care of with an effective fire control; that even without fire going over these upper slopes the mere lumbering would result in washing away the soil?

Mr. CURRIER. It is very apt to. Everything the lumbermen leave is blown down. The bare, rocky soil is only a few inches thick, and it turns up, disclosing bare granite rock.

Mr. WEEKS. Do you not think the State of New Hampshire ought to organize an effective fire control?

Mr. CURRIER. I want to say that the State of New Hampshire will give you any aid. Beyond all question, in my mind, if the Government should take the first step, the State would make purchases direct from the treasury. On the matter of tax, these mountain towns are largely supported by appropriations from the state treasury to-day. The taking of this property away from taxation would simply put a little more burden on the treasury, because we largely support their schools in these wood towns.

The CHAIRMAN. Do you tax the land uniformly in your white-pine country, or do you tax the lumber as it is cut?

Mr. CURRIER. No; we tax the land. We are supposed to tax it at its full value, but timber lands are not taxed at the full value, and particularly the great tracts in the north of the State.

Mr. WEEKS. Do you think it would be inadvisable, if a bill is reported from this committee to purchase lands in any State, that it should be made conditional that a fire control should be established in the State before it is purchased?

Mr. CURRIER. Not at all. Our State would be entirely willing to do that.

Mr. STANLEY. This soil, as I understand you, being very thin, is not the result of any disintegration of the rock, but is just an accumulation of partially decayed débris from the vegetable growth itself?

Mr. CURRIER. If it is let alone it gradually becomes that.

Mr. BEALL. What is the general ownership of the land; is it owned by private individuals or by corporations?

Mr. CURRIER. Private individuals. I suppose the largest timber concern is the Berlin mills, which, by the way, is the largest lumber concern east of Michigan, I believe. They operate under an expert forester, and where the lands will permit, they take out nothing but matured trees, their purpose being to have an inexhaustible supply of lumber, but on the high slopes they can not cut that way.

The CHAIRMAN. Have you heard of any syndicates being formed in the White Mountains which have taken options upon lands with a view to their sale to the Government?

Mr. CURRIER. None except some rumors here; nothing there. The International is a very large timber company, and one or two other paper companies, the Berlin mills, and I do not know what others.

The CHAIRMAN. You do not express an opinion as to the price at which this land could be gotten?

Mr. CURRIER. No.

Mr. BEALL. What is the state of feeling of the individual owners on this question? Do they seem disposed to favor it?

Mr. CURRIER. I do not suppose there is a man, woman, or child in all New England who is not intensely interested in this matter. [Applause.]

Governor GUILD. That is true.

Mr. CURRIER. This committee does not realize how much in earnest we are, and you do not realize, either, the growing feeling in the East that the East is not getting a fair show. [Applause.] Mr. Pinchot says that the forest reserves west of the Mississippi River are worth 1,500 million dollars, and we are asking an appropriation for all this country east of the Mississippi of one-third of 1 per cent, and we think we ought to have it. [Applause.]

Governor GUILD. Mr. Chairman, I regret extremely that my duties in Massachusetts make it imperative for me to leave at this time. The meeting of the executive council has been postponed for twenty-four hours for the express purpose of letting the chief executive of Massachusetts come down here and express the intense feeling of the people of that Commonwealth in favor of this bill and this proposition of forest protection for the whole Appalachian region, from the most northern to the most southern States, and in parting may I thank you, sir, and members of the committee, for the great courtesy which has been accorded me and the kindness and patience with which you have listened to the arguments. I shall take great pleasure in presenting as my successor, Mr. Harvey, of Philadelphia, who will introduce the speakers. Congressman Currier has not exaggerated one moment the intense feeling which prevails in New England in regard to this matter. There are cities in New England which can not run their electric-light plants, and they are now in darkness on account of the drought. There are rivers in Massachusetts, the banks of which have, for the first time, become coated with sewage owing to the lack of the water flow. That, we are informed by the experts in arboriculture, is due to the denudation of the regions at the headwaters of the great rivers of New England, and I think Mr. Ayers will bear me out that whether an exaggerated statement has or has not been made in regard to the southern Appalachians, the condition has not been exaggerated in regard to the White Mountain region, for if the thing continues at the headwaters of the New England rivers at the present rate, the upper slopes there, which we need, will be denuded of trees in five years, and therefore we pray you for immediate action and for the strong arm of the National Government in behalf of the Atlantic slopes. I thank you very much. [Applause.]

The CHAIRMAN. Governor Guild, the committee has felt honored, I am sure, by your presence here to-day, and regrets very much that you can not remain throughout the entire hearing.

We will now listen to Mr. Harvey.

STATEMENT OF MR. WILLIAM S. HARVEY, OF PHILADELPHIA.

Mr. HARVEY. Mr. Chairman and gentlemen, in succeeding our splendid chairman, which honor I appreciate, and also appreciate how incompetent I am to properly succeed him, I will only say on behalf of the many persons here that I was sent here to represent the National Board of Trade, being chairman of the committee on forestry and irrigation; that the National Board of Trade, which represents about 72 boards of trade and chambers of commerce throughout the entire United States, have advocated forestry measures for more than fifteen years. They were among the first advocates of the

creation of the Forest Bureau, for having transferred to the Forest Bureau all the lands that were in the possession of the Department of the Interior that were suitable to be made into reserves, to be cared for under proper forestry conditions. So the National Board of Trade feel that the condition at the present time that has been attained, the education that has developed, the interest that has brought about and created a conservation commission, that the whole country, through the educational work that has taken place throughout these years, has become alive to the importance of the conservation and the utilization of all of our natural resources. I am also here on behalf of the deep waterways and inland waterways people, being identified and associated with them. I also have the privilege and the honor to be the chairman of the executive committee of the American Forestry Association, and we have worked for many years to help to develop and create the sentiment that is making what we want done now possible to be done. We believe, looking at it as we do from the commercial side and not from the sentimental side, that the most important thing we have to consider is the preservation and the intelligent utilization of our forests, especially on the headwaters of all of our streams, if inland waterways are to be developed and transportation is to be furnished, not only for the present, but for the future; that the preservation of the forests and reforestation, and the proper use of them, are the fundamental and underlying questions that are involved in the whole question of conservation and utilization of waterways.

I am not going to burden you gentlemen with an address. I did not come here to do that. I did not come here with any expectation of acting further than as a spectator. I came here "swift to hear but slow to speak." But the people of Pennsylvania, whom I also represent as a member of the conservation commission of the State of Pennsylvania, and had the privilege of representing that State at the conference at the White House as well, are doing, and have done, and have been pioneers in doing, what has been suggested that the States shall do in your hearing to-day. The State of Pennsylvania took this matter up more than fifteen years ago. We now own 830,000 acres of land, much of which was bought, I think, at the averaging price of a little less than \$3 per acre. The State is reforesting. I visited plantations of the State last summer. They have millions of seedlings. They are planting out this year about 800,000 pine trees on the reserves, and the State of Pennsylvania will within ten years have an income from her reserves. Not only that, but the State of Pennsylvania has been the pioneer in one of the most magnificent things that has ever been done by any State, and it shows. Take the city of Philadelphia, which is known as the "City of Brotherly Love." Its influence has extended throughout the entire State, and that praiseworthy element has so influenced the people of the entire State that their interest in suffering humanity has been so great that our legislature appropriated \$1,000,000 a year ago for the establishment of camps for tuberculosis patients on the reserves of the State, and that work is now being done as an example to every State on behalf of those who are suffering from what has heretofore been considered an incurable disease. I visited these camps last summer. The week before I was there 16 men and women had been sent

home cured, after a residence of nine months, and Pennsylvania is the pioneer in that great work. New York has commenced to do the same thing. New York to-day has a million and a half acres in her reserves. Now, Pennsylvania is not asking the Government to purchase any lands for them. I am here as a Pennsylvanian.

The CHAIRMAN. I beg your pardon, but I thought there was a project on hand to induce the Government to purchase a large tract of land in the watershed of the Monongahela and Allegheny rivers.

Mr. HARVEY. At a meeting at Pittsburg I believe that was considered.

The CHAIRMAN. Do you know what sentiment there is back of it; whether in case the precedent should be set, for example, by the passage of this bill, we might expect next year to have a proposal from Pennsylvania to buy a large area in that State?

Mr. HARVEY. Mr. Chairman, I think the suggestion grew out of some of the suggestions that were made to extend the Appalachian reserve all the way up to Pennsylvania, to protect some of the waters. Nothing much grew out of that. It was not a matter by which Pennsylvania was in anyway benefited, just as New Hampshire is not benefited by the use of the waters that have their origin in the State of New Hampshire. A number of our great rivers have their origin in the mountains of Pennsylvania, in the Alleghenies.

The CHAIRMAN. I made the remark only to call your attention to the fact that the proposition which is now before us, of purchasing tracts in the White and Appalachian mountains, is by no means all that we are asked to consider. There are bills before this committee calling for appropriations for similar purchases in a great many other States, and while I think there is none from Pennsylvania, yet I had understood that a movement was in abeyance there, merely waiting favorable action upon this bill.

Mr. HARVEY. I do not think that Pennsylvania is liable to seriously urge that. I hope you gentlemen will excuse me for taking so much of your time. I simply intended to act as the medium of introduction of the other gentlemen who are to be heard, and the next gentleman on our list is Professor Swain, of the technology school at Boston.

STATEMENT OF PROF. G. F. SWAIN, OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

Professor SWAIN. Mr. Chairman and gentlemen of the committee, I had the honor of appearing before you last spring, and I was in hopes that on this occasion it would not be necessary to call upon me again, but that other experts might be brought in my stead. I am very glad that Professor Van Hise appeared before you and that he and others have said a good deal of what ought to be said much better than I could say it. Since last spring there have been some new things come up in regard to the relation of rivers and forests, and to those I will refer somewhat briefly.

The effect of the forests on the streams is concerned mainly with the effect on the rainfall after it reaches the ground. That rainfall, after it reaches the ground, is divided into three parts. One part flows directly from the surface into streams, another part wets the

ground and the leaves and whatever may be on the surface and is evaporated, and the third part percolates into the ground and either descends until it gets to the ground water and is given out in springs or part of it is taken up by plants and used by them in building up their tissues and part of it again is evaporated through their leaves. The preservation of the flow of the streams depends mainly on keeping the percolation of the water into the ground at the expense of what flows directly from the surface. That we can reduce, but later, of course, it percolates into the ground, then the flow will be diminished and the springs will be held up in the dry season of the year. That is what the forest does. The forest bed or floor absorbs the water as it come down and gives it out gradually, and I think a misapprehension, perhaps, exists in regard to the simile which has been made to a sponge, and in that paper which the chairman had that mistake is made fundamentally.

The forest floor is not like a sponge or an impervious surface. It does not simply intercept the water which flows down that impervious surface and filter it as it passes through it and give it out gradually below. The real sponge, the real reservoir, is the soil underneath the bed of the forest humus, and this bed holds the water and allows it to gradually percolate or flow into the soil. A distinction must be made, and a rather sharp one, between the action of forests where the land is flat and where the land is steep. Where the land is flat the most important elements are the evaporation and the percolation; if the land is absolutely flat there would be no tendency for the water to run off; but where the ground is steep there the action of the forest is the most important, and there its action is two-fold. As I said, it retards the delivery into the the streams of the water which ultimately reaches those streams; it holds the water and delivers it gradually to the ground beneath. It is also a great factor during the winter and spring in retarding snow. The snow which falls in the forest stays there much longer than the snow which falls in the open, and it is melted gradually, and therefore is delivered gradually to the streams and fills them up more gradually than if it went off all at once. There are other ways besides these agencies of increasing the percolation. One is cultivation, where the surface of the ground is plowed up; that increases the percolation and allows the streams to be fed, to a certain extent, during the growing season, and on steep slopes, which ought not to be cultivated, or can not be cultivated, the forest is practically the only agency which is useful in conserving this flow of the stream. The flow from the forest, then, is delivered gradually to the streams. It feeds the springs, keeps up the slow water flow, prevents the water from going off suddenly into the streams, and, furthermore, prevents the erosion, because the soil is not carried away by the flowing water. Therefore the relation between the forest and the floods is a perfect and necessary one, and the opinion of engineers, scientists, and geologists all over the world is overwhelmingly in favor of that influence.

As the chairman has undoubtedly seen in the South, if anything absorbs the flow from a cultivated area the water flowing from the steep slopes carries down the soil, and the rush of water obstructs the flow below. Of course, the silt which comes from the mountain is deposited in the first pool. The water takes up the silt according to

its velocity and according to the size of the grains of soil. It deposits them according as its velocity decreases and it is no longer able to carry that silt. And so, as it goes down the stream, it erodes here where its velocity is great and deposits there where its velocity is small, and so it gradually carries the mass of soil to the sea. It always carries some down, and although it may take years for silt to reach the sea from the mountains, it finally reaches there.

The CHAIRMAN. Of course, the silting process takes place in flat countries as well as in mountain countries. The streams in Kansas, for example, which, before the country was settled, were clear streams with rock or gravel bottoms, are now covered with a thick deposit, 3 to 6 feet in the deeper pools, of mud washed in from the surrounding farms.

Professor SWAIN. Yes.

The CHAIRMAN. We could hardly put the country back into prairie grass in order to restore the streams, could we?

Professor SWAIN. No, sir; but you could protect the upper parts of the streams, where the floods arise.

The CHAIRMAN. That is the point I want to make. It is on the mountain slopes where the floods take their rise.

Professor SWAIN. And if those can be protected the floods will be diminished. We can not, however, obviate floods. There will always be floods, and I will explain that presently. In 1898 there was a report of a committee on floods of the Mississippi River, and of that committee Senator Nelson was chairman. In the report they stated that they were unable to find any relation between the cutting down of the woods on the upper Mississippi River and the floods of the Mississippi. The explanation is perfectly reasonable. I presume that committee did not go into any very elaborate study of the phenomena, as they did not have time to do it, and yet I am perfectly ready to admit the general truth of that conclusion. The reason is that that is a flat country, and there could be no relation traced between the floods and the cutting down of timber. That same report states that all of the great floods of the Mississippi come from the Ohio. There you have the thing in a nutshell. The Ohio drains the western slope of the Allegheny Mountains. I think it might have been said that the floods come from the upper portions of the Ohio in the mountain regions. That is the birthplace of the floods, where they gather, in the steep mountain sides and are carried down to the streams.

The CHAIRMAN. Does not the watershed increase in area as you approach the navigable portions of the stream?

Professor SWAIN. Certainly.

The CHAIRMAN. And is it not likely, therefore, as a matter of fact, that the greater portion of the water which causes the flood falls upon that part of the watershed immediately tributary to the navigable portion, and not on the comparatively restricted area of the upper tributaries?

Professor SWAIN. I think not. I think the birthplace of the floods is in the high mountain slopes, and that the control there will have a great deal more efficacy than the control anywhere else. In studying this matter there are great difficulties in tracing their connections, and I would like to dwell upon that just for a minute. The reason of the difficulty is that we can not isolate the phenomena of

the forests from other influences which affect the flow. Let me illustrate by a very homely and unpoetic illustration. If I wish to find the effect of tea and coffee on my child, who has never taken tea or coffee, I do not give tea and coffee together. If I give her tea and coffee together and there is an effect, I am utterly in the dark; it may be due to the coffee and not at all to the tea; it may be due entirely to the tea and not to the coffee. It may be due partly to the tea and partly to the coffee. It may be due to neither separately, but simply to the fact that the two have come together. The influences which affect the flow of streams and floods are varied, and the other influences are more important than forests, for instance, rainfall. There is never a great flood without a great rainfall. The distribution of that rainfall during the year is another very important element.

Take the case, for instance, in countries where the rainfall is principally in the form of snow, in the winter and spring. It goes off and forms a flood in the spring. There is little rainfall during the summer, and the springs get very dry, and the streams practically are dry all during the summer. Perhaps the very next year there may be the same amount of rainfall in the year, but it may be distributed differently. There may be very little in the spring and winter, but there may be a large rainfall in the summer. I was looking at a report of a rainfall the other day in which there had been in two consecutive years the same rainfall, and yet in one year there was a run-off of 12 inches and in the next year, the same rainfall, and run-off with 17 inches. As I say, the influences which are due to the distribution of the rainfall, and so forth, are more important than the forests, but the forests constitute an influence which can be controlled. There are just two elements which enter into the problem which can be controlled. The rainfall can not be controlled; the distribution of the rainfall through the year can not be controlled. All these meteorological phenomena, varied as they are, of course are entirely beyond the control of man. The forests can be controlled, and the other element which could be controlled is the storage. By forests and storage together the flow can be regulated to the greatest possible degree. The storage alone, without the control of the forests, would itself be rather futile, because if the trees are cut down erosion follows and the reservoirs are more apt to fill up with silt, and in time to lose their power of storage because they lose their capacity.

President Van Hise has referred to the important study which has been made the past summer in regard to the rainfall. It is a very remarkable thing that during the last ten years of the period studied there were more days of flood than during the first twelve years, and perhaps a cursory examination would make one come to the conclusion that there had been less floods, therefore, and that cutting down the trees in the valley had been a fatal influence on the floods. But when you study the rainfall you will see the explanation, and the thing that Mr. Leighton has done has been to combine those two as they have never been combined before. He has taken the number of rain storms which are sufficient to produce a flood, and he has compared those with the number of days of flood, and the result is perfectly definite, as Doctor Van Hise has stated. It shows an increase of flood in proportion to the days of rainfall, or in proportion to the number of rain storms, of about 18.75 per cent.

The CHAIRMAN. Is that result definite unless you know when the rains occurred; that is, in what way they came? As you suggested a little while ago, there might be one year of rainfall that would give a certain number of floods, and another year of precisely equal rainfall that would give a different number of floods, because differently distributed. Does Mr. Leighton's report take account of that?

Professor SWAIN. It takes some account of that; yes, sir. There are difficulties in tracing any direct relation, and I think, Mr. Chairman, that the proper way to arrive at a conclusion, the way which appeals to me, is by a study of the elementary influences, a study of the forest bed, the measurement of the percolation into the soil, and the actual observation of the way the streams come from the forest land, and the way they come from the deforested land. Those, I think, will convince anybody that there must be a relation there which is definite, and that cutting down the trees has a large effect in diminishing floods.

I would like to refer briefly to one or two objections which are sometimes made to that theory. Fifty years ago a French engineer published a work in which he attempted to show that cutting down the forests diminished the floods. That had no effect on the French Government, and evidently was not shared by the government engineers, because the French Government immediately began thereafter to adopt a forest policy and to expend large sums in the reforestation of the mountains. Recently, within a few months, an American engineer, a member of the Corps of the Engineers of the Army, has published a paper, which the chairman has referred to, in which he gives almost the identical arguments which were given fifty years ago by the French engineer. I hope they will be followed by the same action which was followed in France. One of the arguments made is that sometimes the forests may increase the flood, as, for instance, suppose the snow lies late in the forests and there comes a warm rain. That warm rain carries off the snow and the flood results, and that flood is larger than would have resulted from that warm rain if the forests had not retained the snow. That is perfectly clear, but it is equally clear that if the forests had not been there that snow would have gone off in the earlier floods, as Congressman Weeks has suggested, and that those earlier floods would have been largely increased. The effect of the forest is to distribute the discharge into the stream in a given amount.

Mr. WEEKS. Do you know any engineer of good standing who agrees with Colonel Chittenden in his conclusion?

Professor SWAIN. I have not met with any, sir; and I hope that the chairman of the committee will read the discussion on Colonel Chittenden's paper which will appear in the proceedings of the American society in connection with the paper itself.

The CHAIRMAN. There is one other question more I would like to ask Mr. Swain, because he has evidently studied this very deeply. You will remember another argument of Colonel Chittenden is that the forest will actually diminish the flow of water in a river by reason of absorbing an ordinary rainfall which, if the forests were not there, would flow into the stream and increase its volume, but which, the forest being there, is absorbed and held and does not get into the stream in time to do it any good.

Professor SWAIN. That is exactly what we wish to have occur. We want to have the forest bed absorb the water and thereby give it out as a benefit.

The CHAIRMAN. His argument is this, that after a long-protracted drought the streams get no benefit whatever of the small showers that fall during that interval, as they would if the forests were not there, but the forest itself is giving out no water, suffering from the general drought; that the humus and the leaves of the trees themselves take up this shower and give none of it back to the streams.

Professor SWAIN. The answer to that is, perhaps, another question, What happens when there are no showers which fall on those areas during the summer? We had an example of that in New England and over a large section of country this summer. We had a drought in New England during a period much longer, preventing the water from running from the extreme headwaters of any of the streams to the sea. Colonel Chittenden's idea seemed to be that he admits that the forests keep up the flow of springs, and he says that because each spring is small you can have all of them dry up without appreciable effect, and then he goes on to say that the showers will come on the denuded areas you have on this watershed, and then the next, and then the next, in such a way as to be properly timed, you will keep up the low water flow. That will hardly be a safe method to depend on.

The CHAIRMAN. The drought throughout New England and other Eastern States this year was more severe than had been known for one hundred years, practically.

Professor SWAIN. I do not know; it has been very severe.

The CHAIRMAN. It is not sought to create the impression here that the conditions which prevailed this year were due solely to the denudation of the forests?

Professor SWAIN. No; but aggravated by the denudation of the forests.

Mr. HARVEY. I would like to announce, gentlemen, that as there are quite a number who are anxious to be heard from, I shall be obliged to request each gentleman in the future to confine himself within five minutes, and I shall tap on the table when the five minutes are used up and give him about half a minute within which to close.

STATEMENT OF MR. W. S. LEE, HYDRAULIC ENGINEER, OF CHARLOTTE, N. C.

Mr. LEE. Mr. Chairman, I want to confine my remarks to two questions, which you have asked us to discuss. The first is the flow of the streams in the Appalachian Mountains, regarding the clearing of the timber from any particular stream. I have been at work for several years on different hydraulic problems there, and the first thing that we do to ascertain the flow is to get some idea of the timbered section that that stream is running through, and you will find that streams down in North Carolina, upper South Carolina, and Tennessee will vary in the flow per square mile of run-off—that is, in cubic feet per second—from 1.2 cubic feet down to 0.28 of a cubic foot, with practically the same rainfall on the entire area. The stream that is in the most heavily wooded section furnishes about

three or four times the amount of water a square mile during the low-water period, the time that you need water for water power purposes or for navigation, and you would be surprised to find how close two streams are and how much they will vary in flow. But that can be in each case traced absolutely to the amount of cleared land that you have in the drainage area of that particular stream.

The other point that I wanted to go over slightly was the silt or sand that is deposited by these streams. I remember very distinctly about twelve years ago I was on a water-power plant on the Seneca River, just above the junction of the Seneca and the Tallulah, where the Savannah River is formed, between North Carolina and Georgia. The Seneca River was a little to the east, yet went back into the mountains the same as the Tallulah. This river was always muddy, or carried a great deal of silt and sand. The Tallulah River, that came into the Savannah, was a clear stream. There was sand and silt all up the Seneca River. The Tallulah River had very little, if any, but since that time the Tallulah River is each year gradually becoming muddier and carrying more silt farther up.

The CHAIRMAN. Has that come from the clearing of farm land or from lumbering operations?

Mr. LEE. That is from both. There is a great deal of lumbering going on in that immediate section, and this land was only farmed for two or three years. Where this timber is cut off the ground is very rich from the deposit of trees, and you can grow a crop for two or three years very profitably, and then it soon washes away, and there are plenty of those slopes that are cleared merely for the purpose of getting two or three crops off them.

The CHAIRMAN. Then there would be a return to the forest?

Mr. LEE. Yes; they are abandoned and go through a process of going back to the forest. If they are not too steep they will eventually reforest themselves. I do not know that I should care to discuss any other points.

STATEMENT OF MR. D. A. TOMPKINS, OF CHARLOTTE, N. C., PRESIDENT OF THE SOUTHERN APPALACHIAN ASSOCIATION.

Mr. TOMPKINS. Mr. Chairman, the phase of this subject that I will undertake to touch upon is the same as Mr. Lee has spoken upon, but from a little different point of view. I have had the water power for a company in North Carolina on one of the streams for ten years, and built a cotton mill to use the water power. I took very great pains to get what was the preceding high-water mark, in order that we could put the mill floor above the possibility of water getting into it, and we made an allowance of 3 feet. Within the period that this mill has been built there has been a constant denudation of the forest on account of timbering and other things, and the high-water mark has been constantly rising until the last flow came within 6 inches of the floor which we had put about 3 feet above the high-water mark. At the same time, in the interim of the floods, the water that goes over the dam has diminished certainly one-third, making wider and wider variation between the water that can be used all the year for power and the water that comes as a flood. This is not only applicable in that particular case, but it is applicable in

a great many other cases of water powers and in the cases of water powers that are being developed for general use, aggregating, perhaps, all told, 200,000 horsepower of water power—powers that are doing the work of at least 2,000,000 people, and that means to us, on account of this changing condition which I observed in a practical way, that there is imminent peril to a large vested interest and to the vocations of a great many people.

Now, you appropriate \$100,000,000 a year to support an army to defend the people of this country against imminent peril; you support a navy at a cost of \$125,000,000. We believe that \$5,000,000 is an exceedingly modest sum to ask for to protect the large vested interests throughout the eastern part of the United States against an imminent peril, which is just as serious as invasion would be. Suppose Boston was threatened with an invasion that was going to do a great injury, you would appropriate \$50,000,000 inside of two days to relieve Boston of that danger. We are undoubtedly in the presence of an imminent danger as serious as if Boston was going to be attacked from the sea or by land. We think, also, that it is a practical question, that you can argue here indefinitely and never reach any conclusions about a great many phases of the subject that are naturally going to be worked out by scientific people afterwards, and not by people in Congress; whether the water flows from the streams into one stream or another will be a subject that will have to be evolved from experience, and if you were to appropriate enough money to make a beginning, then you would have some experience, and some experts who could better tell you how to proceed next. That picture at your window represents a view of forest and stream. That was one of the conditions attracting people from other countries to this, our forefathers. President Roosevelt sent some pictures yesterday to Congress that show the condition a country may be brought to by neglect. You have all heard, of course, that when the hills of Lebanon were forested with cedars, Palestine supported ten millions of people in opulence. We know that to-day Palestine supports less than 500,000 people in poverty. There was a time when in Jerusalem there was a building finer than this one, they say, and yet what is that building to-day, and its condition was largely brought about by the physical degeneration of the country. We ask you to make an appropriation and make a start now. We ask it in absolute good faith and in the belief that there is an imminent peril, and that you should as promptly do this as you would if there was an invasion of the country; and when you make a start you will not only be convinced of the importance of keeping it up, but you will get the skill and knowledge of the facts to base the project on that ultimately it will not cost the Government anything, because the rivers will bring in enough to pay for the thing.

Mr. WEEKS. How far back did you go to get that high-water mark you speak of?

Mr. TOMPKINS. I went back to the time when people 80 years old had gotten it, as far back as their memories would carry. We got the best average result through the knowledge of the oldest inhabitants, and I think we got it pretty nearly right, because we have observed that the high-water mark has been increasing since. We measured the low-water flow before we bought the property, and we

have measured it lately, and it is very seriously diminished. We know that high water is higher than it ever was before. It is rapidly coming to the time when we should take hold of this subject, because a few years will make all the difference in the world. The diminution and the increase of floods in the drought are separating themselves in a geometric ratio in just a few years.

Mr. WEEKS. Suppose you were going to build a dam on the stream to-day, would you build any stronger dam to develop the same horsepower than you did ten years ago when you built the one you speak of?

Mr. TOMPKINS. The dam that I did build takes these floods and just rolls them over the top, and it does not make any difference about the flood so far as it holds the water; the excess water flows over the dams. Our trouble is twofold, less water in a dry time and a filling up of the pond. Our pond is practically filled up there. We have to depend on the regular flow of water, and the quantity of the water flowing in in drought is less than it used to be. That is, we have less water at times than we used to have.

Mr. HASKINS. It fills up with silt and sand?

Mr. TOMPKINS. Yes, sir; it fills up with silt and sand.

The CHAIRMAN. Do you think that diminished flow is due to the fact that your reservoir is filled up?

Mr. TOMPKINS. The diminished flow is not, but if the silt and sand did not come down, we could store water all night and run it during the day. That resource has been completely taken away from us, but the actual flow is less than it used to be. We do not pretend to know just the best way to proceed about this thing, and we ask Congress to appoint people who do know how to remedy it and we will do it promptly.

Mr. HARVEY. The next gentleman we shall hear will be Mr. C. C. Goodrich, of Connecticut.

STATEMENT OF MR. C. C. GOODRICH, OF CONNECTICUT, GENERAL MANAGER OF THE NEW YORK AND HARTFORD GENERAL TRANSPORTATION COMPANY.

Mr. GOODRICH. Mr. Chairman and gentlemen of the committee, I have been requested by Governor Woodruff to appear at this hearing. I do not know that the Governor expected me to say anything, because I am not a speaker; I am not used to appearing before a committee, and yet the chairman this morning asked for information on certain points that it did seem to me, perhaps, I could be of use to him in. First, as to the flow of the Connecticut River, as observed, and as to the building of the bars and the final disposition of the sand as it reaches the sea. I have been for forty years engaged in marine commerce, at the present time handling more than 40 vessels of from 500 to 5,000 tons register. I have observed in all these years, going back even further than my service as the manager or vice-president, and I remember the time when our river, forty years ago, received its high-water season and continued it away along until the middle of June, when the common inquiry was, "How much snow is there left in the forests in the White Mountains in New Hampshire and in Vermont?" We could depend in those years upon operating without difficulty from low water until about the

15th of June. In those days the Government had not undertaken the care of its rivers and its waterways as within the last twenty years. The result was that those who were using the rivers for their commerce were obliged to have their own dredges for service in summer, their own lighting system for the various rivers, and their own range lights to guide across the various bars which are forming between Hartford, Conn., and Long Island Sound. In that service we could start our dredges about the 10th of May, in which time the flow got so that we could reach the bar in about 20 feet, and about the 1st of July we had the courses cleared out at an expense of about \$58,000, and the rest of the season we could go on with our commerce.

In the last twenty years, and right down to the present time, in an aggravated way, the length of high-water flow in spring has been exceedingly shortened. Starting with March, freshet after freshet comes with an immense waste of water, freshets ranging from 15 to 20 feet follow close upon one another, so that we lose the use of the water, and by the 20th of May, instead of the 15th of June, we arrive at a point where a full loaded passenger steamer of 1,500 tons must wait, must stop, or else instead of dredging in accordance with the present channel of 150 feet wide, with 9 feet at low water in summer, we must leave one bar and immediately go to another, where we have only a 25-foot channel, just enough to drop the keel into it, and then make another 10 miles, and still another 10 miles, and then put in another 50 or 60 feet wide at the bottom of the slope, and gradually in that way we can keep the daily line of passenger steamers that operate in that river in operation by having every great steamer and having the Government engineers immediately attack another bar and keep going. We have been able to navigate very successfully there, and in that time we have been able to dredge through those bars, only half the width that the Government project calls for.

If we continued and carried out and spent the rest of the appropriation, amounting in those days to about \$16,000 for two years, or about \$20,000, out of which the Government received its proportion for the proportionate expense of the engineering department in that district, we found we were throwing away the money, that we could get through with a 70-foot channel, and that we have done right down to the present year for the last ten years, and I presume we may continue to get along in that way for a good while to come. In speaking of the moving of this sand, which I would like to take up now, for I think, without having statistics that the chairman asked for, I have forty years of practical experience, and I know that which is coming and that which has come. I know how the sand has come through the forest down there, and how it moves; that the sand is composed of a clean, white grit, as sharp as diamonds; that it is heavier than the alluvial soil. At every point from Hartford to the Sound, at every wide bank, this sand deposits, and that makes the bar, say, from 300 to 1,600 feet across, so in the three miles we may have from one to three miles of dredging in each year. As we dredge those bars, that sand, under the direction of the officers of the Government, is deposited in the only place where it can be put, as far out of the channel as we can put it. When the river carries down silt from the mountain it brings a deposit, and that deposit is dropped below this bar, and in the course of the next year it brings up at the next place, and in the course of a number of years it reaches the

mouth of the Connecticut River. At that point it is building a shoal straight off to sea on the east side of the mouth of the river, being one and one-half miles shoaling water, to as shoal as three feet on the crest of the bar, and where the buoy guards the outer edge you immediately drop off to 120 feet. I am now looking to south. Looking to the east, that bar extends five miles to the eastward. The extensions are going on at the outskirts.

Looking soundward, over between the jetties at the mouth of the river, we have about 3 miles out the long sand shoals, which takes that portion and carries it to the west. That is 6 miles long, and there is a passage between that and the main shore. It lies pretty nearly in mid sound. That drops off into water from 8 to 12 feet, but 150 feet abreast of the light-vessel that is placed there to guard it, called "Cornfield light shoal vessel." It might be thought that the constant action in washing this sand off to sea must eventually blockade the mouth of the river. I noticed that the chairman spoke this morning of the Columbia River. I know that the Connecticut River, when you have extended this shoal off $1\frac{1}{2}$ miles from shore and have practically made a dam a mile and a half into the Sound, you have so confined the easterly and westerly flows of those tides past the Connecticut River, that from that day forward the rapidity and force of the current past the eastern buoy and the western spar on the Cornfield Shoal would have such great rapidity that at least $2\frac{1}{2}$ feet in three years on each tide of water is a mass of moving smooth sand, rolling over and over, and coming to the surface in perfect piles; so if the Connecticut River continued to discharge this great mass forever, there would be no use of farther building at this point toward the west. The extension would be to the east and west. I know that 20 miles to the westward and eastward, as it moves out of this rapid current, it never gets back toward the Connecticut River, but it does line the shore for all those miles with every southwest storm or southeast storm. It is driven on the shore until the shore now extends 20 miles to the westward and 30 to the eastward. There is no alluvial mud in it.

Now, Mr. Chairman, if there is any other matter that I could help you at all on, or that you would like to ask me, for my experience is all in marine work, and consequently I do not think I am able to help you much otherwise, I will be glad to answer any questions. I will say this, that on that same long sand shoal in thirty-five years there have been more than 20 vessels wrecked, of which my own fleet furnished 2.

The CHAIRMAN. Has there been any material change in that time in the area of cultivated land along the watershed of this river?

Mr. GOODRICH. I do not think that in the forty years that the cultivated area has increased any. The fact is that the great meadows there are level, and when a 20-foot freshet floods them they are greatly productive of fine grass, but I will say that not 20 per cent of these meadows are cultivated. The country further back is cultivated to a greater or less extent, but not so greatly as to foul the discharge in the river. Our water finds its way to the sea, with the exception of a short time, perhaps a month in a year, in a very clear and cleanly flow.

Mr. HARVEY. The next speaker will be Mr. McFarland, president of the American Civic Association.

STATEMENT OF MR. MCFARLAND, PRESIDENT OF THE AMERICAN CIVIC ASSOCIATION.

Mr. MCFARLAND. Mr. Chairman and gentlemen, I have no statistics to present and very little time to take. I speak for the American Civic Association, which has to do with about 100,000 persons interested in making a better and more beautiful America. We want the forests because we need them for their health, their comfort, and the pleasant part of living. We want them because they are good to see and good to be in, as well as good to use. We want forests because they are beautiful as well as useful, because they give us the rest and peace and pleasure that comes to those who go into the forests, at the same time furnishing us with the vast resources in commercial life included in the timber industry. We want forests because they are the one element of our national wastefulness which we can both have and use. We are here in the new Office Building. It is made of stone. The stone came from the earth and no more stone is growing. It is lighted by metal fixtures and glass globes, all made from the earth, and no more metal and glass is growing. There is wood in the room and that we ask you to preserve. The building itself is created from the inexhaustible resources of the earth, and we ask that in serving beauty, in serving health, and making pleasant and profitable the lives of citizens, we also conserve these great national resources which we so greatly need. We want, Mr. Chairman, that forests shall be had in the East and in the West, so that the national flag may stay floating on the staff. The flag itself we can make over again, because the wool will continue to grow on the backs of the sheep, at least to a certain degree, but after we have denuded the forests we will have to have in that case iron flag poles. Taking it as a national question, we believe that we can hold up the national honor when the flag is floating from wooden poles.

Mr. Chairman, it seems to me that the attitude of the gentleman from North Carolina who discussed the problem is the right one. You are entering practically upon a national forest policy, of which this Appalachian and White Mountain bill is but an incident. It is, it seems to me, worth while to have instituted a national-forest policy for the national welfare and the national defense, and I submit to you, with some little knowledge of how the country looks upon this thing, that you will be supported in any action you take which looks to the creation of a national-forest policy, as much as to the creation and continuance of a national-irrigation policy. Vast millions are spent for national defense and homes. We have the post-office everywhere: we have rural free delivery everywhere: we certainly are not specially provided with national control of forests everywhere. We in the East look with some regret also upon the West with its forests, purely incidental forests, gentlemen, and we hope that there may be forests in the East. Consider, if you please, that the present forest condition is an advantageous condition. The forest reserves owned by the National Government just happened; we never bought that part of the national domain upon which it did happen that trees were growing. In the East there is no such condition. We speak for a wide-spread national-forest policy, of which the present incidental action is but an item, which will round up into the guarding by the

Government—by the Federal Government in the case of the weakness or the unwillingness of the State—of that resource without which we can not live, not only for its commercial importance, but for its influence on our lives, our morals, our health, and the welfare of the country in which we live.

STATEMENT OF MR. C. J. H. WOODBURY, SECRETARY OF THE NATIONAL ASSOCIATION OF COTTON MANUFACTURERS.

Mr. WOODBURY. Mr. Chairman, at the last hearing I appeared before you with a committee of our association, which includes all of the principal cotton mills from the Atlantic States, excepting Florida, and also Alabama and Mississippi. These twelve thousand and odd men in executive positions in the cotton mills, operate over 20,000,000 spindles, with a capital, with the subsidiary bleachers and dye works, of something like \$750,000,000. They are viewing with apprehension this terrible peril of the waste by flood, and they instructed me to come here and express their sincere wish that you would take some action along the line of these hearings, of which you have had many particulars, and therefore on account of the shortness of the time I will omit going into those particulars, stating that these cotton manufacturers in the several States have done all that they could in the matter of the State reserves, town reserves, and some corporations are planting great numbers of trees, two of them 30,000 apiece to my knowledge, on the lands which they happen to control on their watersheds, and that is all I have to offer, on account of the shortness of the time. The feeling is in favor of this project on the part of these manufacturers, whose work has been held up by the freshets and droughts, which have also shut off not merely the operation of the manufacturing but probably its capital, and also that of the thousands and thousands of the help which they employ. The question is regarded as an exceedingly serious one, and one that is growing in regard to what I believe to be the greatest single industry in this country.

STATEMENT OF MR. A. W. BUTLER, OF ROCKLAND, ME., REPRESENTING GOVERNOR WILLIAM T. COBB.

Mr. BUTLER. I come here at the request of Governor Cobb, as he was detained by official business in Maine. I know that the governor is much interested in this measure. I find that there is a large constituency in Maine that are interested in it and believe in immediate action, so far as it is possible or so far as it may be possible for immediate favorable consideration. We not only feel interested for these particular localities, but for the general effect upon our States, in which we believe there should be a wider and larger supervision of the forests and the general resources. I have talked with two men to-day from Maine who are interested and engaged in the lumber business in Maine, and they expressed to me very earnestly their desire and wish that this measure should be adopted, and that no further delay than was possible to take immediate action should be had, because our physical conditions are changing. Our forests are being cut off and our water supply diminished. It is my own view and my earnest wish, and I think I represent a large constituency, that you will take favorable action upon this subject.

STATEMENT OF DR. GEORGE L. GAY, PRESIDENT OF THE AMERICAN MEDICAL ASSOCIATION.

Doctor GAY. Mr. Chairman and gentlemen of the committee, I have been asked to appear here as the representative of the American Medical Association, the largest medical organization in the country. There are three of that association here, Doctor Jacobi, of New York, Doctor Mussey, of Philadelphia, and myself from Boston. Doctor Jacobi is at the New Willard attending the conservation commission having its meetings there.

Governor Guild asked me to speak to you for a moment as to the results of the low streams upon the health of the community. If there is a doctor on the committee, and I hope there is, for there ought to be a doctor on every committee that has anything to do with public health, he knows very well, if he has lived in the country, that there is more sickness when the streams are low than there is when the streams are high. There is one disease that is particularly a water-borne disease, and that is typhoid fever. I hope you have all had it, gentlemen, because if you have, you will not have it again. If you have not, you are in daily risk of getting it. It is carried in water more than it is carried in any other possible way, and while this is not the time or the occasion for the committee to say anything about pollution of streams, yet this Congress will never do its duty to the people of this country until they prohibit the pollution of water resources. Why the inhabitants of one state should be obliged to drink the excreta of another state, the typhoid fever poison or any other poison of another state, passes our comprehension.

The low stream, as I say, is a constant source of danger. We have 30,000 deaths from typhoid fever in this country every year. We have more than 200,000 cases of typhoid fever in the country every year. A case of typhoid fever that gets well in two months is a fortunate case. That means 400,000 months of lost time, supposing they were all laboring people, wage earners, which of course they are not. Anybody who is fond of figures can carry out that computation to his satisfaction. It is one of the most widespread diseases. There are only one or two that beat it—consumption and pneumonia—and it is a preventable disease. There are many diseases that are not preventable and we are not to blame for them, but when we have a preventable disease it is our duty to do all we can to prevent it, and keeping our streams full of water is one of the methods of prevention, and the other very important method of prevention I hope will come before Congress before many years. I thank you gentlemen for your attention.

Mr. HARVEY. Mr. Chairman, we will endeavor to make our word good, and on behalf of all of the interests that are here represented, it gives me great pleasure to express our appreciation of the great courtesy and consideration that you gentlemen have given us in the patient hearing and the patient manner in which you have listened to what we have all had to say. The knowledge which you have obtained from your study of this question and its merits has impressed all of us who have been here to-day.

The questions that have been asked by your distinguished self as chairman and the other members of your committee have all been

questions of the most pertinent nature, some of which should have been answered in a more pertinent way than they have been answered; and the only reason, perhaps, that they were not answered as conclusively or as convincingly as they should have been may have been because the questions have been asked of the wrong man, and some of us feel that when we are asked a question on a subject with which we are not perfectly familiar we ought to be frank enough to say we are not familiar with that subject and that somebody else ought to be asked that question, and therefore not jeopardize a case, the real merits of which we are most anxious to uphold. We have with us a large number of people who would like to have been heard. We have the president of the Orange Judd Agricultural Publishing Company; Ralph W. Pope, secretary of the American Institute of Electrical Engineers; Herbert Nyoick; Mr. E. A. Start, secretary of the Massachusetts Forestry Association; and Mr. F. W. Rane, state forester of Massachusetts. I would like to have the stenographer to take their names as being among those present who would like to have been presented to your committee; and in thanking you, we sincerely hope—in fact, we feel confident—that nothing we can say can further impress you gentlemen with the importance and significance of what we are asking, and if there is anything that we can do to help you to find a way, we would like to do it, and we sincerely hope you will find a way.

The CHAIRMAN. The committee feels that it is under obligations to you, to Governor Guild, and to the other governors and gentlemen who have appeared here to-day, for the information that has been brought before us. We hope you realize that it is one thing to notice a desirable object to be gained, and quite another thing to assume the responsibility of determining exactly the means through which that object shall be reached. I realize myself that those who have been for so many years advocating this measure may feel justified in a degree of resentment, if I might use so strong a term, at the delays that have resulted.

Mr. HARVEY. If I may interrupt you, Mr. Chairman, I would rather say that I think there is no feeling represented here by anyone of resentment; it is rather one of sorrow that it has not been possible to take this action.

The CHAIRMAN. I felt as if I were using a little stronger word than the occasion required, but the right one did not come to my mind. The idea I wish to convey to your mind, however, and to the minds of the other gentlemen here, is that this committee appreciates the responsibility that rests upon it, and is earnestly and honestly and patriotically trying to do its duty in the premises, and I wish to repeat the expression of my thanks to you and those who have been here for the help you have given us.

Mr. HARVEY. It gives me great pleasure to state sincerely that I believe every one who has appeared before you honestly believes that the committee is honest and sincere and anxious to do what can be done, if it can find a way to do it.

(Thereupon, at 4 o'clock p. m., the committee adjourned.)

COMMITTEE ON AGRICULTURE,
HOUSE OF REPRESENTATIVES,
January 28, 1909.

At an executive session of the committee held on this date a motion prevailed that all after the enacting clause of S. 4825 be stricken out and the following (known as the "Weeks bill") be substituted:

AN ACT For acquiring national forests in the Southern Appalachian Mountains and White Mountains.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the consent of the Congress of the United States is hereby given to each of the several States of the Union to enter into any agreement or compact, not in conflict with any law of the United States, with any other State or States, for the purpose of conserving the forests and the water supply of the States entering into such agreement or compact.

SEC. 2. That the sum of one hundred thousand dollars is hereby appropriated and made available until expended, out of any moneys in the National Treasury not otherwise appropriated, to enable the Secretary of Agriculture to cooperate with any State or group of States, when requested to do so, in the protection from fire of the forested watersheds of navigable streams, and the Secretary of Agriculture is hereby authorized, and on such conditions as he deems wise, to stipulate and agree with any State or group of States to cooperate in the organization and maintenance of a system of fire protection on any private or state forest lands within such State or States and situated upon the watershed of a navigable river: *Provided*, That no such stipulation or agreement shall be made with any State which has not provided by law for a system of forest-fire protection: *Provided further*, That in no case shall the amount expended in any State exceed in any fiscal year the amount appropriated by that State for the same purpose during the same fiscal year.

SEC. 3. That the Secretary of Agriculture, for the further protection of the watersheds of said navigable streams, may, in his discretion, and he is hereby authorized, on such conditions as he deems wise, to stipulate and agree to administer and protect for a definite term of years any private forest lands situated upon any such watershed whereon lands may be permanently reserved, held, and administered as national forest lands; but such stipulation or agreement shall provide that the owner of such private lands shall cut and remove the timber thereon only under such rules and regulations, to be expressed in the stipulation or agreement, as will provide for the protection of the forest in the aid of navigation: *Provided*, That in no case shall the United States be liable for any damage resulting from fire or any other cause.

SEC. 4. That from the receipts accruing from the sale or disposal of any products or the use of lands or resources from public lands, now or hereafter to be set aside as national forests, that have been or may hereafter be turned into the Treasury of the United States and which are not otherwise appropriated, there is hereby appropriated for the fiscal year ending June thirtieth, nineteen hundred and nine, the sum of one million dollars, and for each fiscal year thereafter a sum not to exceed two million dollars for use in the examination, survey, and acquirement of lands located on the headwaters of navigable streams or those which are being or which may be developed for navigable purposes: *Provided*, That the provisions of this section shall expire by limitation on the thirtieth day of June, nineteen hundred and nineteen.

SEC. 5. That a commission, to be known as the "National Forest Reservation Commission," consisting of the Secretary of War, the Secretary of the Interior, the Secretary of Agriculture, and one member of the Senate, to be selected by the President of the Senate, and one member of the House of Representatives, to be selected by the Speaker, is hereby created and authorized to consider and pass upon such lands as may be recommended for purchase as provided in section six of this act, and to fix the price or prices at which such lands may be purchased, and no purchases shall be made of any lands until such lands have been duly approved for purchase by said commission: *Provided*, That the members of the commission herein created shall serve as such only during their incumbency in their respective official positions; and any vacancy on the commission shall be filled in the manner as the original appointment.

SEC. 6. That the commission hereby appointed shall, through its president, annually report to Congress, not later than the first Monday in December, the

operations and expenditures of the commission, in detail, during the preceding fiscal year.

SEC. 7. That the Secretary of Agriculture is hereby authorized and directed to examine, locate, and recommend for purchase such lands as in his judgment may be necessary to the regulation of the flow of navigable streams, and to report to the National Forest Reservation Commission the results of such examinations: *Provided*, That before any lands are purchased by the National Forest Reservation Commission said lands shall be examined by the Geological Survey and a report made to the Secretary of Agriculture, showing that the control of such lands will promote or protect the navigation of streams on whose watersheds they lie.

SEC. 8. That the Secretary of Agriculture is hereby authorized to purchase, in the name of the United States, such lands as have been approved for purchase by the National Forest Reservation Commission at the price or prices fixed by said commission: *Provided*, That no deed or other instrument of conveyance shall be accepted or approved by the Secretary of Agriculture under this act until the legislature of the State in which the land lies shall have consented to the acquisition of such land by the United States for the purpose of preserving the navigability of navigable streams.

SEC. 9. That the Secretary of Agriculture may do all things necessary to secure the safe title in the United States to the lands to be acquired under this act; but no payment shall be made for any such lands until the title shall be satisfactory to the Attorney-General and shall be vested in the United States.

SEC. 10. That such acquisition may in any case be conditioned upon the exception and reservation to the owner, from whom title passes to the United States, of the minerals and of the merchantable timber, or either or any part of them, within or upon such lands at the date of the conveyance; but in every case such exception and reservation, and the time within which such timber shall be removed, and the rules and regulations under which the cutting and removal of such timber and the mining and removal of such minerals shall be done shall be expressed in the written instrument of conveyance, and thereafter the mining, cutting, and removal of the minerals and timber so excepted and reserved shall be done only under and in obedience to the rules and regulations so expressed.

SEC. 11. That whereas small areas of land chiefly valuable for agriculture may of necessity or by inadvertence be included in tracts acquired under this act, the Secretary of Agriculture may, in his discretion, and he is hereby authorized, upon application or otherwise, to examine and ascertain the location and extent of such areas as in his opinion may be occupied for agricultural purposes without injury to the forests or to stream flow and which are not needed for public purposes, and may list and describe the same by metes and bounds, or otherwise, and offer them for sale as homesteads at their true value, to be fixed by him, to actual settlers, in tracts not exceeding eighty acres in area, under such joint rules and regulations as the Secretary of Agriculture and the Secretary of the Interior may prescribe; and in case of such sale the jurisdiction over the land sold shall, *ipso facto*, revert to the State in which the lands sold lie. And no right, title, interest, or claim in or to any lands acquired under this act, or the waters thereon, or the products, resources, or use thereof after such lands shall have been so acquired, shall be initiated or perfected, except as in this section provided.

SEC. 12. That, subject to the provisions of the last preceding section, the lands acquired under this act shall be permanently reserved, held, and administered as national forest lands under the provisions of section twenty-four of the act approved March third, eighteen hundred and ninety-one (volume twenty-six, Statutes at Large, page eleven hundred and three), and acts supplemental to and amendatory thereof. And the Secretary of Agriculture may from time to time divide the lands acquired under this act into such specific national forests and so designate the same as he may deem best for administrative purposes.

SEC. 13. That the jurisdiction, both civil and criminal, over persons upon the lands acquired under this act shall not be affected or changed by their permanent reservation and administration as national forest lands, except so far as the punishment of offenses against the United States is concerned, the intent and meaning of this section being that the State wherein such land is situated shall not, by reason of such reservation and administration, lose its jurisdiction nor the inhabitants thereof their rights and privileges as citizens or be absolved from their duties as citizens of the State.

SEC. 14. That twenty-five per centum of all moneys received during any fiscal year from each national forest into which the lands acquired under this act may from time to time be divided shall be paid, at the end of such year, by the Secretary of the Treasury to the State in which such national forest is situated, to be expended as the state legislature may prescribe for the benefit of the public schools and public roads of the county or counties in which such national forest is situated: *Provided*, That when any national forest is in more than one State or county the distributive share to each from the proceeds of such forest shall be proportional to its area therein: *Provided further*, That there shall not be paid to any State for any county an amount equal to more than 40 per centum of the total income of such county from all other sources.

SEC. 15. That a sum sufficient to pay the necessary expenses of the commission and its members, not to exceed an annual expenditure of twenty-five thousand dollars, is hereby appropriated, out of any money in the Treasury not otherwise appropriated. Said appropriation shall be immediately available, and shall be paid out on the audit and order of the president of the said commission, which audit and order shall be conclusive and binding upon all departments as to the correctness of the accounts of said commission.

Amend the title so as to read "An act to enable any State to co-operate with any other State or States, or with the United States, for the protection of the watersheds of navigable streams, and to appoint a commission for the acquisition of lands for the purpose of conserving the navigability of navigable rivers."

Thereupon, by vote of the committee, it was ordered that Mr. Weeks and Mr. Lever be requested to report the bill to the House.

It was further ordered that the paper upon "Forests and reservoirs in relation to stream flow with particular reference to navigable rivers," read before the American Society of Civil Engineers, by Lieut. Col. H. M. Chittenden, of the Corps of Engineers, U. S. Army, be incorporated in these hearings, together with the comments of Dr. George F. Swain thereon, and a letter from Colonel Chittenden to the chairman of the committee in reply to Doctor Swain's comments; and also the majority and minority reports on the bill S. 4825.

The documents referred to appear as an appendix to this volume.

APPENDIX.

FORESTS AND RESERVOIRS IN THEIR RELATION TO STREAM FLOW WITH PARTICULAR REFERENCE TO NAVIGABLE RIVERS.

[By H. M. Chittenden, M. Am. Soc. C. E.]

The following paper is presented at this time with the purpose of eliciting from the society membership the results of observation and experience touching the important matters of which it treats. They are vital features of one of the chief living questions before the public to-day, and an expression of views by men accustomed to look at things from a practical standpoint can not fail to be of great value to our legislators upon whom the ultimate responsibility for action must rest.

While the author's views traverse to some extent currently accepted theories, they are based upon long observation and study and are what seem to be unavoidable conclusions therefrom; but he is committed to no theory as such and his mind is entirely open to conviction upon any point in which his opinions may be shown to be erroneous. His sympathies are wholly on the side of the present movement for the conservation of our natural resources, and, so far as this paper takes issue with certain tendencies of that movement, it is only for the purpose of inquiring whether such tendencies are not really inimical to the cause to which they pertain.

With this preliminary statement, the author will take up the first part of his paper, viz., the influence of forests upon stream flow.

FORESTS AND STREAM FLOW.

The commonly accepted opinion is that forests have a beneficial influence on stream flow:

(1) By storing the waters from rain and melting snow in the bed of humus that develops under forest cover, preventing their rapid rush to the streams and paying them out gradually afterwards, thus acting as true reservoirs in equalizing the run-off.

(2) By retarding the snow melting in the spring and prolonging the run-off from that source.

(3) By increasing precipitation.

(4) By preventing erosion of the soil on steep slopes and thereby protecting water courses, canals, reservoirs, and similar work from accumulations of silt.

There are many subsidiary influences, but, broadly stated, the above propositions cover the ground. They were first given general currency nearly forty years ago through the writings of Sir Gustav Wex, chief engineer on the improvement of the Danube, whose treatise was translated into English by the late General Weitzel, of the Corps of Engineers. Wex's theories were stoutly resisted at the time by many European engineers, and still find only a limited acceptance in the profession,^a though in the popular mind they have gained ground, and in the United States are now accepted practically without question.

To establish by definite proof the truth or falsity of these propositions is an extremely difficult task. One would not think so, indeed, to judge from the cheerful confidence with which the popular thought accepts them; but it is nevertheless so. The elements of the problem are so many and conflicting, the necessary evidence is so hard to get, and comparative records are of such recent date, that precise demonstration is scarcely possible. The popular belief is based upon a fact and an assumption, forming together a basis for a conclusion. The fact is

^aAlmost simultaneously with the publication of Wex's treatise, a similar work was published in France by M. F. Vallée, taking exactly the opposite view of the question.

that forests in the eastern portion of the United States have disappeared to a large extent within the past century. The assumption is that floods and low waters in the same region are more frequent and severe than before the forests were cleared away. The conclusion is that these assumed conditions must be due to the disappearance of the forests. Post hoc, ergo propter hoc is the argumentative process relied upon, and little effort is made to consider whether there may not be some other and more satisfactory explanation. The author will attempt to analyze the problem from a theoretical standpoint, and will then cite existing records so far as these are sufficiently long continued to be worth anything. He will consider, first, the effect of the forests where stream flow results from rain alone, and, next, where it results in part from melting snow.

Effect of forests upon the run-off from rainfall.—The first of the above propositions—the retentive action of the forest bed—may be accepted at once as strictly true for average conditions. It is not true for extreme conditions—great floods and excessive low waters—the conditions that determine the character and cost of river control. Consider an inclined-plane surface, practically impervious to water, with a layer of sand covering some small portion of it, and let a uniform spray of water be applied to the entire surface. Assume that the temperature and rate of evaporation are relatively low. As soon as the spray begins water commences to flow from the uncovered surface, but not for a time from that covered by the sand. After a while it begins to trickle from the sand, increasing in volume until the sand is thoroughly saturated, after which it flows off in as great quantity per unit area as from the uncovered portion. If the spray is stopped the water immediately ceases to flow from the uncovered area, but continues in diminishing quantity from the covered area until it finally ceases altogether; but not all the water that fell on this area has run away. The sand has retained some portion of it and given it off in evaporation, so that the total run-off per unit area is somewhat less than on the uncovered portion. If the shower be long-continued and the rate of evaporation very low, the difference of total run-off per unit area from the two surfaces will be very slight.

Suppose now that the temperature and rate of evaporation are high and that the spray works intermittently. If the showers are small in volume and the intervals between them long, the sand may retain nearly or quite all of the individual showers and give them off in evaporation, so that there will be no run-off whatever.

Between these two extreme conditions the covered area will exert a greater or smaller regulative effect upon the run-off. The retentive power of the sand will be less as the slope of the surface upon which it rests increases, or it will be greatest when the surface is nearly horizontal and least when it is nearly vertical.^a

^a Since the above was written the author has noticed, in the report of the hearing on House resolution 208 before the Committee on the Judiciary, that Gifford Pinchot, Associate American Society of Civil Engineers, Chief of the Forest Service, used an illustration very similar to that given above, except that he failed to carry it to its logical conclusion. Addressing the committee February 27, 1908, he said: "I have in my hand here a photograph of a denuded hillside. After the forest has been removed rain falls on that hillside and runs off rapidly, as the water I drop upon the photograph does now, and disappears instantly. [Illustrating.] If, on the other hand, I place a forest cover on the hillside that is exactly analogous in texture and effect with this piece of blotting paper and drop the water slowly upon it, we would find that, instead of running off slowly at the bottom, the water is held. [Illustrating with blotting paper.] Part of it runs off, but as soon as the absorbent quality of the paper or the forest floor has time to take effect the water is kept and drips gradually for a considerable length of time off the hill into the stream. This is an exact illustration of the way in which the forest controls the stream flow on that hillside."

Mr. Pinchot should have completed his illustration. He should have continued to sprinkle the paper long enough and heavily enough to have saturated the paper completely, in order to show that the water would then flow from the paper as rapidly as from the uncovered area; and he should then have explained that this condition represents what always happens in the forest in times of great flood. Then he should have sprinkled the paper intermittently in small quantities, and at such long intervals that the warm air of the room would evaporate all of the absorbed water, and that none whatever would flow away. He should then have explained that this condition represents what always takes place in the forest in times of great drought.

Now, in nature this ideal illustration is never fully exemplified in the cleared land and the forest. There is nearly everywhere a marked retentive capacity in the bare soil. In newly plowed ground it is probably greater than in the forest. Moreover, certain crops, like heavy grass or grain, obstruct the flow of water almost as much as the forest cover. On the other hand, the furrows of cultivated fields, drainage ditches, roads, and particularly the pavements and roofs of towns, greatly accelerate the run-off; so that, while the full contrast of the ideal example does not exist in nature, the principle of the illustration applies perfectly. That is, there are times when the percentage of retention in the forest bed is 0, and there are other times when it is 100; or, there are times when so much water comes that the forest bed can hold none of it, and there are times when so little comes that it holds it all. Between these extremes there are periods when it holds more or less and gives up less or more and exercises a corresponding influence upon the run-off. There is another important condition not exemplified in the illustration, and that is that the forest areas are scattered everywhere, the ground has an infinite variety of slope, the showers never fall uniformly over an entire watershed, and the final result in the total run-off is the summation of tributary results.

It is true, therefore, as popularly understood, that in periods of ordinary rainfall, with sufficient intervals for the forest bed to dry out somewhat, forests do exert a regulative effect upon run-off. They modify freshets and torrents and prolong the run-off after storms have passed, and thus realize in greater or less perfection the commonly accepted theory.

This result utterly fails, however, in those periods of long-continued, widespread, and heavy precipitation, which alone cause great floods in the large rivers. At such times the forest bed becomes completely saturated, its storage capacity exhausted, and it has no more power to restrain floods than the open country itself. Moreover, the fact that the forest bed has retained a portion of earlier rainfall and is yielding it up later to the streams, produces a condition that may be worse than it would be in a country cleared of forests. Really great floods in large rivers are always, as is well known, the result of combinations from the various tributaries. It is when the floods from these tributaries arrive simultaneously at a common point that calamitous results follow. Any cause which facilitates such combinations is, therefore, a source of danger. Now, unquestionably, in a heavily wooded watershed forests do have a tendency in this direction. When a period of heavy storms occurs, spreading over a great area, continually increasing in intensity, the forests, by retaining some portion of the earlier showers and paying them out afterwards, do produce a general high condition of the river which may greatly aggravate a sudden flood arising later from some portion of the watershed. That the forest does promote tributary combinations there would seem to be no question, and that it may therefore aggravate flood conditions necessarily follows. It is not contended that this increase is ever very great, but it is contended that forests never diminish great floods and that they probably do increase them somewhat. The forests are virtually automatic reservoirs, not subject to intelligent control, and act just as the system of reservoirs once proposed by the French Government for the control of floods in the River Rhone would have acted, if built. These reservoirs were to have open outlets, not capable of being closed, which were intended to restrain only a portion of the flow. A careful study of their operation in certain recorded floods showed that they would actually have produced combinations more dangerous than would have occurred without them.

Consider now periods of extreme drought and grant that as a general rule, springs and little streams dry up more completely than when forests covered the country, although this difference is very greatly exaggerated in the popular mind.^a At first thought one would conclude that, since the springs and streams make up the rivers, these also ought now to show a smaller low-water flow than formerly. This, however, is not the case. The difference between

^a The term "as a general rule," is used, for it is by no means absolute. In particular the drainage of low swamp lands leads off into the streams, in dry weather, waters that formerly remained or passed off in evaporation, and in such cases even the low-water flow is greater than it used to be. In 1895 the author saw an example of this on the Scioto River near the outlet of the great Scioto swamp, which had recently been drained. A small mill was able to operate during the low-water season more regularly than formerly. Tile drainage, now so widely used, has the same tendency.

the former low-water flow of a spring or rivulet and what it is now is relatively an insignificant quantity. Most of such water sources yield but a small fraction of a cubic foot per second. Whether these small quantities are a trifle more or less cuts very little figure in the aggregate; and so it counts but little in the flow of a great river whether some of its extreme sources lose a portion of a volume that is already inappreciable. When the summer showers come, however, there is a marked difference. At such times the forests not only hold the water back—they often swallow it completely. Small showers that make a perceptible run-off in the open are often practically all absorbed in the leaves of the trees. Heavier showers, that make freshets in the open, are largely absorbed in the leaves and forest bed and pass off in evaporation; so that, contrary to the general view, the evaporation from the forest is greater at such times than in the open country and the run-off from summer precipitation is less. A single shower may produce a sufficiently greater run-off in a deforested area to more than offset the diminished low-water flow for several weeks.^a Now, on most of the smaller streams quantity of flow is a more important matter than natural uniformity of flow, particularly in the summer time. The day of the small mill, which was so dependent upon such uniformity, is past. The modern water power invariably seeks uniformity by artificial regulation, and the ups and downs of its sources of supply are abolished in its storage. Therefore it does not matter nearly as much that the run-off of the small streams be uniform as that it yield a good flow of water; and if forests diminish the total low-water supply, this fact more than offsets the gain in uniformity. Likewise the great rivers swallow up and equalize the small irregularities of their headwaters and actually experience a somewhat larger low-water flow than if their watersheds were still thickly forested. Thus, while forests may decrease somewhat the extreme range between maximum and minimum run-off on very small watersheds, they do not do so on great ones, which are combinations of very small ones. At the same time it seems certain that forests decrease somewhat the total run-off from watersheds, small or great.^b

Influence of forests upon snow melting.—The second proposition—that forests have a beneficial effect upon the run-off from snow melting—is quite as firmly fixed in the popular belief as that just considered, but has even less foundation in fact. It is a relation that can be definitely traced, and it can be demonstrated that the effect of forests upon the run-off from snow is invariably to increase its intensity. This results from two causes, one affecting the falling of the snow and the other its melting.

In the first place, forests break the wind, prevent the formation of drifts, and distribute the snow in an even blanket over the ground. In the open country, the snow is largely heaped into drifts, their size depending upon the configuration of the ground, the presence of wind-breaks, and the prevalence and force of the wind. These drifts form admirable reservoirs and in the high mountains are the most perfect known. Forests prevent their formation entirely.

The period of snow melting begins in the open country much earlier than in the forests. At first the melting is due mainly to the direct action of the sun's rays before there is sufficient warmth in the general atmosphere to produce any effect. The thinly covered areas melt off first and the streams experience a diurnal rise and fall following the warmth of day and the frost of night. Nothing like a flood ever arises from such melting.

Under forest cover this action is interfered with more or less, depending upon the density of the shade. Even after the ground in the open is entirely bare, except under the drifts, the forest areas may still be covered with an unbroken layer of snow. It is generally, though erroneously, considered that this delay is beneficial, by carrying farther into the summer the release of the winter pre-

^a So far as the author is aware, Col. T. P. Roberts, of Pittsburgh, Pa., was the first to call attention to this characteristic of stream flow.

^b This subject was ably discussed by Mr. Raphael Zon, of the Forest Service, Department of Agriculture, in Transactions, Am. Soc. C. E., Vol. LIX, pp. 494-495. He states, among other things, that "the quantity of water available for stream flow from forested watersheds, all other conditions being equal, is less than from nonforested watersheds;" that "the forest soil receives least precipitation, next comes meadow land, and lastly tilled land;" that "in the forest, only the upper layer of the soil is moister than in the open, the lower layers being always drier." This discussion is well worth perusal.

cipitation and giving it more time to soak into the ground; but in fact this benefit does not result. The water from the first melting of the snow blanket does not sink into the ground but into itself. Snow is like a sponge. A panful will shrink to one-fourth of its volume, or less, before any free water appears. The author has seen an 8-foot covering of snow dwindle to 2 feet, with the ground beneath is still comparatively dry.

The forest shade thus holds the snow, which gradually becomes saturated from its own melting, until the heat and warm rains of late spring or early summer arrive, the soft air everywhere pervading the forest depths and finding a maximum exposure of surface to the melting influences. A cubic yard of snow, which in a great drift might stand 27 feet deep with a square foot of exposure, may here lie with a depth of 1 foot and 27 square feet of exposure. The result is that when the final melting begins the whole body of snow disappears very rapidly, rushing from every direction into the streams, swelling them to their limits and often causing disastrous freshets. The active melting lasts but a short time, and there is little opportunity for the water to soak into the ground. The delay in melting, caused by the forest shade, has simply operated to concentrate it into a shorter period and increase the intensity of the resulting freshet. It comes so fast that the greater portion of it can not be utilized at the time and is lost altogether unless intercepted by reservoirs.

In the open country, on the other hand, the drifts last for weeks after the snow has entirely disappeared from the forest, and continue to yield a supply of water far into the summer. The period of active melting in the open may have lasted four months, that in the forest scarcely as many weeks. In the northwest corner of Wyoming and contiguous portions of the adjoining States lies an elevated region of probably 20,000 square miles, which is the source of nearly all the great river systems of the West. It is a very remarkable region in this respect. Its average altitude is about 7,500 feet, and it is in large part covered with a dense evergreen forest. At the very summit of this elevated region is that singular section now visited annually by thousands of tourists—the Yellowstone Park. The opening of the tourist season in spring occurs just about the time of active snow melting, and the most onerous and difficult task of those in charge of the road system of the park is to get the roads into condition for the first travel. This frequently has to be done while the snow still lies deep on the ground. It was the repeated execution of this task that first drew the author's attention to the fact that, as a general rule, the floods of this region are forest floods, and that the same conditions of precipitation which force the forest streams out of their banks produce only moderate effects in the open. The traditional "June rise" comes mainly from the mountain forests.

A photograph, taken about the middle of June in a year of heavy snowfall and only two days before the tourist season opened, shows an east and west road through a dense forest of lodgepole pine at an altitude of 8,200 feet. It shows very effectively the deep, even blanket of snow everywhere covering the ground, except along a narrow strip at the roots of the trees on the north side of the road, where the sun had access through the opening in the tree tops caused by the 30-foot clearing for the roadway. Another, taken practically at the same time, shows one of the great drifts in the open country, which it was impossible to avoid in locating the road.

At this time a period of very warm weather had set in, with frequent rains. Severe floods followed, which did great injury to the roads and bridges, not only in the mountains, but for a considerable distance below. Within two weeks the snow had practically disappeared in the forests, but in the open country the drifts, like that in the photograph, continued until the middle of July, giving forth a continuous supply of water.

A most illuminating article, and one which everyone interested in the subject should read, was published in Science for April 10, 1896. It gives the results of observations in the mountains of Nevada for over twenty-five years, during which "extensive tracts of timber" were cut off "to the very ground" and new growths had been well started. It was found that springs which were active after the land was cleared dried up when the new forest growth developed; "that the water supply from the mountains is greater and more permanent now than it was before the timber was cut off;" that freshets were no more "frequent or violent than before the trees were cut off," and that "spring floods were less frequent." The greatly increased loss due to evaporation in the forest was pointed out. This results partly from the vast extent of surface on the ground exposed to the air and partly from exposure on the leaves and branches of the trees.

"The foliage on this class of trees being as heavy in winter as in summer, the branches catch an immense amount of the falling snow and hold it up in mid-air for both sun and air to work upon; and only those who have had experience of the absorbing power of the dry mountain air can form any idea of the loss from that source." Moreover "the trees absorb from the soil quite as much water as would be evaporated by the action of the sun in the absence of the shade."

The writer states that "the strongest force at work to save our rivers is the drifting winds which heap up the snow in great banks; and in this the trees are a constant obstacle." He declares that "close observers, after long years of study, have been led to believe that if there is any difference in the flow of streams and the size of springs before and after the trees are cut from above them, the balance is in the favor of the open country."^a

In the current literature upon this subject one invariably encounters the same fallacious assumption, that because the forests delay melting their action is therefore beneficial. The fact is entirely overlooked that delay means concentration and greater intensity of run-off, while the open country prolongs the melting and gives a more even distribution. If the true action of forests in this respect, however, is rarely recognized by public writers, it is recognized, though perhaps unconsciously, by those who are benefited by it. The monthly reports of the Weather Bureau in the Rocky Mountain region are instructive reading in this connection. The following are a few extracts from those sent in to the central office of the western Montana district at Helena:

"Where there is no timber to break the force of the winds solid drifts of considerable depth have collected." * * * "The snowfall has been very light and the drifts are not large or solid enough to furnish an adequate flow of water in the streams." * * * "In some sections the winter's snowfall has been the lightest for many years, and as there is little likelihood that the later snows will form solid drifts, it is practically certain that the flow of water in most streams will be inadequate for irrigation and mining purposes."

These extracts, which could be multiplied indefinitely, show how well the practical ranchman understands the value of snowdrifts. It has always been a mystery to the author that writers will persist in statements like the following, which appears in one of the ablest addresses at the recent conservation conference in Washington :

"The possibility of irrigation depends largely on the preservation of the forest cover of the mountains, which catches and holds the melting snows, and thus forms the great storage reservoirs of nature."

The forests destroy the reservoirs and the flow would be more uniform, prolonged, and plentiful if they were not there.

It will doubtless be urged that while the foregoing conclusions may hold for an elevated and densely wooded region, they will not hold for a lower altitude, warmer climate, and different kind of forest. In reply it may be said that in proportion as the conditions described prevail, they apply everywhere. In deciduous forests where the foliage is absent during seasons of snowfall and melting, the winds have greater play in winter and the sunlight in spring, and there is, of course, less difference between the forests and the open country: but while the difference is less it is not obliterated altogether, and in hilly regions, like the Adirondacks and the White Mountains, it exists in full force. The author is very familiar with the region of western New York—having been reared on a farm nearly on the divide between the waters of the Ohio and Lake Erie—a beautifully wooded country, deciduous growths prevailing, and one of the snowiest regions in the United States. While there is less drifting in the open, and more in the woods than in high mountains, still it is strictly true that the open-country drifts outlast the forest snows just as the latter outlast the thin snows in the open.

^a The author recalls only a single other writer who has set forth this matter in accordance with the facts, and that was an anonymous correspondent in a recent issue of the Pacific Sportsman. His view of the case is summarized in rather terse language as follows: "Trees in the mountains make floods in the spring." "Snow in the timber melts too fast. The timber keeps it from drifting." "The agency which maintains the river is the snow in the huge drifts." "That (the drift) is your reservoir that feeds the living streams of summer time." "The timber has nothing to do with the water supply, but is a result of the water supply."

A striking example of the action of forests on snow melting may be seen in the mountains of the Pacific coast. Here are the densest forests in the world, the deepest beds of humus, and the most perfect reservoir effect so long as it is in action. Yet in this very region, particularly around Puget Sound, are to be found some of the most torrential streams in the country. This fact is largely due to the distribution of snowfall caused by the forests. Conditions like the following are constantly developing. Heavy snowstorms sweep over the forest-covered mountains. The snow can not drift, for the dense woods break the wind. A great deal of it does not reach the ground at all, but hangs on the branches and undergrowth all the way from the highest tree tops down. This covering is often so dense as to prevent cruising operations altogether, because the cruisers can not see the timber through the impenetrable screen of snow. Of an 18-inch fall, perhaps 12 inches is on the trees and the rest spread evenly on the ground. To show what now happens, let an illustration be drawn from the opposite process of drying clothes. When the housewife has finished her washing and wishes to dry the clothes, she does not set them out in a basket, where it would take weeks for them to dry, but spreads them upon the ground or hangs them on a line so that the sun and air can reach them on all sides. So these forests increase, by a thousandfold, the exposed area of the snow over what it would be if heaped in nature's clothes baskets (the great drifts), and give it the maximum possible exposure to the melting influences whenever these shall arrive. As a general rule these snowstorms are followed by warm southerly winds and rains—the rains frequently heavy in themselves—and rain and snow join hands, two storms in one, and rush down to the ocean in tremendous freshets and floods. The Skagit River, the largest in Washington except the Columbia, and a very considerable stream, has been known to rise 1 foot per hour for sixteen hours, and this where the stream has a fall of 4 feet to the mile, and carries off its floods very rapidly. A photograph taken on another stream with only 480 square miles of watershed above it, shows the terrific power of these streams that come down from the most densely wooded and perfectly protected watershed in existence. The great flood of 1906 in this section was a perfect demonstration, not only of the vast intensifying effect of forests upon floods due to snow melting, but of the utter helplessness of the forest bed, when saturated with long rains, to restrain floods.

The same effect was very manifest in the great flood of 1907 in the valley of the Sacramento River, California. The tributaries on the east side come down from the densely wooded slopes of the Sierras; those on the west side from the bare or sparsely wooded slopes of the Coast Range. If the forest theory be true, these smooth western slopes should send down a greater flow for the same precipitation than the eastern slope. Exactly the reverse seems to have been the case. For the period, March 17-26, the precipitation on the Puta Creek watershed, on the west side (805 square miles), averaged 22.7 inches. The maximum resulting run-off per second per square mile for one day was 39.1 cubic feet. Directly across the valley on the Sierra slope the precipitation, on the American River watershed (2,000 square miles), averaged 14.6 inches for the same period, and the maximum daily discharge was 48.7 cubic feet per second per square mile. Considering the fact that unit run-off for the same conditions is always less the greater the watershed, this result is quite remarkable. It is undoubtedly due to the action of the Sierra forests on snow melting, and again illustrates the inability of forests to exercise any restraining influence upon great floods.^a

During the spring of 1908 occurred a record-breaking flood in western Montana, nearly all the streams on both sides of the Continental Divide going far over their banks. As might have been predicted, this occurrence was promptly cited as another example of the effect that a forest-barren country has upon floods. Nevertheless it is as certain as anything of this kind can be, that if the country affected by this extraordinary downpour (in some places breaking all previous records) had been thickly forested, and the ground still covered, as it would have been, with a solid layer of saturated snow, the flood would have

^a In the paper, *The Flood of March, 1907, in the Sacramento and San Joaquin River Basins, California*, by Messrs. Clapp, Murphy, and Martin, published in *Proceedings American Society of Civil Engineers* for February, 1908, the author says: "In the Sierras the greater part of the precipitation is normally in the form of snow, and the magnitude of floods depends largely on the rate of melting. A heavy warm rain on deep, freshly fallen snow produces a maximum run-off."

far exceeded in magnitude and destructiveness that which actually took place. Wherever forests existed in the higher altitudes they did have this effect.^a

Having now considered the influence of forests upon stream flow from a theoretical standpoint, let the records themselves be examined as far as they are available. These records in the United States, unfortunately, are not so useful as might be wished, because of their brevity. No continuous records on any of our streams run back for more than eighty years, and most of them less than half as far. This is far short of the two hundred years considered by certain European engineers who investigated Wex's theories as the minimum period "necessary in order to draw a reliable conclusion" upon this subject. It does indeed seem absurd to take present-day records, as is constantly done, and draw conclusions one way or the other as to comparisons with the past, of which records are entirely wanting; but such as they are, a few of these records are given in Table 1. They include in most cases both high and low water, although the low-water records can not, in the nature of the case, be of very much value. Works of channel improvement on most of the streams have probably affected somewhat the low-water stages for the same discharge, while, as is well known, a given stage, even in a natural stream, does not mean the same discharge at different times.^b It is really the discharge of the streams rather than the stage that forms the correct basis for comparison: but data for discharge are almost wholly wanting.

An examination of these records shows how utterly impossible it is to find anything in them to support the current theory of forest influence. They prove conclusively that there has been no marked change since the settlement of the country began, and that such change as there has been is on the side of higher high waters and lower low waters before the forests were cut off. What the record would be if we could go back two hundred years can not be said, but it may safely be conjectured that it would show both floods and low waters that would equal or surpass any modern record. It is the experience of every engineer who has the opportunity to observe the action and study the history of great rivers to find everywhere evidence of the occurrence of higher waters than any of which he has positive record. The upbuilding of bottom lands, the survival of old water marks, and many other indications show that, great as are modern floods, those of the past were greater still. In the very nature of the case, it is not possible to find similar evidence of former low waters, because such evidence is wiped out by every succeeding high water; but whoever will take the trouble to study records of early expeditions on our rivers, when barges, keel boats, and similar craft were used, will conclude that extreme low water is not a modern development by any means. Measurements of the Monongahela River, at Brownsville, in 1838 and 1856, low-water years, gave discharges of 75 and 23 cubic feet per second, respectively. It is quite certain that the river has not fallen so low in late years. At Pittsburg in 1895 (the driest season in recent years) it fell to 160 feet.

^a In the Weather Bureau report, Montana section for June, 1908, it is stated that "the rainfall was phenomenally heavy over most of this district, and, combined with the water from the rapidly melting snow in the high mountains, caused unprecedented floods in nearly all streams."

^b During the past twenty years the low-water stage of the Mississippi at St. Paul has been materially modified by reservoir action.

TABLE 1.—*Gauge records of certain rivers of the United States—Highest and lowest stages for each year.*

MISSISSIPPI.

Year.	St. Paul.		St. Louis.	
	Highest.	Lowest.	Highest.	Lowest.
1785			a 40.6	
1826			? 33.7	
1828			36.4	
1838			27.0	
1843			27.2	
1844			41.3	
1845			32.4	
1846			25.0	
1849			27.4	
1851			36.5	
1852			28.0	
1853			30.0	
1855			37.1	
1856			27.4	
1858			37.0	
1860				0.6
1861			25.5	1.3
1862			31.5	3.5
1863			18.0	0.0
1864			20.3	1.2
1865			26.8	1.2
1866			2.2	5.6
1867			3.0	1.2
1868			2.0	1.0
1869	16.1	2.8	29.2	4.7
1870			26.2	5.2
1871			21.8	2.8
1872	7.7	1.9	23.0	2.4
1873	16.4	2.4	25.5	4.6
1874	11.6	3.0	18.4	2.8
1875	18.0	2.1	30.0	2.3
1876	11.0	1.9	31.8	5.0
1877	7.7	1.8	26.5	7.0
1878	6.7	0.6	25.7	5.6
1879	10.8	0.9	21.2	3.4
1880	15.3	1.7	25.5	2.7
1881	19.7	3.3	33.6	7.6
1882	13.3	2.9	32.0	2.8
1883	12.5	1.5	34.8	4.5
1884	10.3	1.8	28.1	3.0
1885	7.4	1.9	27.1	2.0
1886	8.2	1.2	27.0	1.4
1887	9.6	0.8	20.6	0.9
1888	14.4	2.4	29.4	3.2
1889	4.5	0.8	24.6	2.5
1890	7.0	0.6	20.5	2.8
1891	6.4	0.1	23.7	3.0
1892	12.6	1.0	36.0	1.0
1893	14.7	0.6	41.6	-0.2
1894	11.8	0.2	23.3	0.2
1895	4.6	0.2	23.4	-0.5
1896	10.7	0.9	27.7	3.7
1897	18.0	2.3	30.9	-0.5
1898	10.7	2.8	27.2	0.3
1899	11.0	2.4	25.7	-1.0
1900	6.6	0.7	23.5	-2.5
1901	7.5	1.2	22.5	-2.0
1902	7.5	1.1	26.8	-1.0
1903	13.5	2.5	38.0	0.6
1904	9.9	2.6	33.6	-0.1
1905	14.8	2.0	30.2	-0.3
1906	13.3	4.9	26.2	3.0
1907	13.6	1.3		

* L'année des grandes eaux.

TABLE 1.—*Gauge records of certain rivers of the United States—Highest and lowest stages for each year—Continued.*

OHIO.

Year.	Pittsburg.		Cincinnati.		Louisville. ^a	
	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.
1810	32.0					
1813	29.0					
1816	33.0					
1832	34.0		64.2		40.8	
1840	26.9					
1846	25.0					
1847	26.0		63.6			
1848	23.0					
1851	30.9				20.3	1.5
1852	31.9					
1853	31.9					
1855	18.0	2.1				
1856	19.6	0.3				1.1
1857	21.4	0.0				
1858	26.0	0.5	43.1	2.5	19.1	1.5
1859	22.0	1.1	55.5	3.3	33.8	2.0
1860	29.7	2.8	49.2	5.3		
1861	30.9	1.1	49.4	5.1		
1862	30.0	0.3	57.3	2.3		
1863	16.0	0.1	42.7	2.5		
1864	18.6	1.0	45.1	3.1		
1865	31.4	1.4	56.2	5.7		
1866	15.4	0.4	42.5	4.7	18.6	2.8
1867	22.6	0.0	55.7	3.0	37.6	1.8
1868	20.6	0.0	48.2	5.1	22.3	3.0
1869	19.6	0.7	48.7	5.3	24.3	2.8
1870	18.0	1.3	55.2	3.8		
1871	19.0	1.2	40.5	2.7		
1872	20.6	1.6	41.7	3.0	21.0	2.0
1873	25.6	1.6	44.4	3.7	18.3	2.3
1874	22.4	1.1	47.9	2.3	22.4	1.8
1875	25.0	0.4	55.3	4.2	30.3	2.7
1876	26.0	0.2	51.7	6.2	32.5	3.7
1877	25.0	0.7	53.7	3.2	29.9	2.2
1878	24.6	0.0	41.3	4.3	15.7	2.9
1879	20.0	0.1	42.7	2.5	19.6	2.2
1880	22.0	0.3	53.1	3.7	30.0	2.8
1881	28.0	0.6	50.6	1.9	22.5	1.7
1882	21.9	0.6	58.6	6.1	37.4	4.7
1883	27.6	0.1	66.3	3.6	43.8	3.2
1884	34.4	0.3	71.0	2.7	46.7	2.0
1885	23.0	1.0	46.0	2.5	22.2	2.9
1886	22.8	0.3	55.7	3.3	32.7	2.4
1887	22.0	2.0	56.2	2.7	32.5	2.2
1888	26.0	0.0	39.9	5.2	16.1	3.6
1889	24.0	0.2	38.2	5.2	13.8	3.5
1890	24.3	1.2	59.2	5.7	35.3	3.6
1891	31.3	1.9	57.3	4.4	32.4	2.8
1892	23.0	1.3	43.7	3.4	21.9	2.1
1893	24.0	1.5	54.9	3.6	28.8	2.0
1894	23.2	2.0	35.6	3.1	12.8	2.2
1895	25.8	1.2	48.4	2.3	20.7	1.8
1896	23.0	2.0	47.8	5.5	22.4	3.9
1897	29.5	1.7	61.2	3.1	35.3	2.4
1898	28.9	2.2	61.4	4.5	36.3	3.1
1899	22.0	2.4	57.4	3.4	32.8	2.2
1900	27.7	1.6	40.0	3.2	15.4	2.0
1901	27.5	0.8	58.7	4.2	33.2	2.8
1902	32.4	1.1	50.9	3.9	24.8	2.8
1903	28.9	0.0	53.1	4.5	28.7	2.8
1904	30.0	1.7	45.9	3.3	22.9	2.0
1905	29.0	1.0	48.2	6.5	22.0	3.1
1906	18.5	0.0	50.2	7.1	26.4	3.1
1907	35.5	0.0	65.2	7.0	41.2	3.4

^a Upper gauge.

TABLE 1.—*Gauge records of certain rivers of the United States—Highest and lowest stages for each year—Continued.*

TENNESSEE.

Year.	Chattanooga.		Florence.	
	Highest.	Lowest.	Highest.	Lowest.
1867	58.6		31.1	
1871				0.0
1872			16.4	-0.8
1873			22.9	-0.5
1874		0.7	26.0	0.0
1875	54.0	2.2	29.4	0.4
1876	31.1	1.0	19.8	-0.6
1877	28.7	1.2	19.4	0.0
1878	19.2	0.9	13.6	-0.8
1879	38.0	0.2	21.5	-0.5
1880	38.3	1.0	24.5	0.1
1881	22.4	0.0	17.4	0.0
1882	40.2	1.7	29.6	1.2
1883	38.2	0.0	23.3	0.4
1884	42.8	0.2	25.2	0.3
1885	30.4	0.7	17.8	0.6
1886	52.2	1.2	28.1	0.5
1887	27.3	1.2	17.5	0.5
1888	27.0	1.8	20.8	0.7
1889	29.6	2.1	19.7	1.2
1890	42.5	2.0	23.3	1.7
1891	38.9	1.2	22.2	1.0
1892	37.9	1.1	24.0	0.8
1893	33.4	1.6	21.4	1.1
1894	25.5	0.7	17.7	-0.1
1895	32.1	0.7	17.5	0.0
1896	40.5	1.1	20.0	0.1
1897	37.9	0.4	32.2	-0.5
1898	24.6	1.6	13.8	0.4
1899	40.0	0.8	25.2	-0.1
1900	24.3	1.0	19.5	0.1
1901	37.4	2.1	18.9	0.8
1902	40.8	1.2	21.7	-0.4
1903	31.8	0.6	18.8	-0.5
1904	22.1	0.1	17.2	-0.5
1905	22.4	1.2	16.7	0.0
1906	33.3	3.2	16.7	1.5

MISSOURI.

Year.	Kansas Cit .		Year.	Kansas City.	
	Highest.	Lowest.		Highest.	Lowest.
1844	26.0		1891	23.1	2.5
1873	19.3	2.0	1892	24.9	1.5
1874	16.2	1.5	1893	18.1	3.1
1875	17.8	1.8	1894	20.1	4.3
1876	18.0	2.0	1895	16.9	3.3
1877	22.2	3.8	1896	19.2	2.8
1878	19.8	3.5	1897	22.8	2.0
1879	19.2	3.2	1898	21.5	4.0
1880	16.7	? 2.0	1899	23.3	5.2
1881	26.3	3.0	1900	17.8	4.2
1882	19.2	1.2	1901	19.4	3.7
1883	23.8	? 5.0	1902	23.2	3.5
1884	? 17.2	? 3.0	1903	35.0	3.5
1885	19.1	3.8	1904	25.2	2.1
1886	15.8	0.2	1905	28.0	2.0
1887	20.2	1.8	1906	19.7	2.8
1888	20.4	4.7	1907	24.0	4.1
1889	13.9	3.2	1908	30.5	8.7
1890	17.2	0.2			

* Approximately.

TABLE 1.—*Gauge records of certain rivers of the United States—Highest and lowest stages for each year*—Continued.

CONNECTICUT.

Year.	Springfield.		Year.	Springfield.	
	Highest.	Lowest.		Highest.	Lowest.
1801	21.0		1887	17.0	2.1
1843	20.4		1888	17.7	2.2
1854	22.2		1889	11.3	3.2
1862	22.0		1890	11.7	2.8
1869	20.4		1891	14.3	2.8
1871	13.0	0.10	1892	13.8	3.0
1872	14.2	1.10	1893	18.2	2.1
1873	15.0	0.6	1894	10.4	2.6
1874	17.5	1.0	1895	20.2	3.4
1875	15.0	0.8	1896	20.2	3.5
1876	17.0	0.6	1897	15.3	3.8
1877	16.5	1.2	1898	15.5	3.8
1878	18.5	1.2	1899	16.2	3.6
1879	15.8	1.6	1900	17.0	3.6
1880	10.8	1.0	1901	19.8	3.6
1881	11.5	1.7	1902	19.3	3.1
1882	10.9	1.6	1903	17.4	3.1
1883	14.6	1.8	1904	15.3	3.1
1884	16.0	2.2	1905	17.6	3.6
1885	13.3	2.4	1906	15.1	3.0
1886	16.0	1.6	1907	15.5	3.3

The point should be fully recognized that these records are valueless for establishing either side of the forestry argument unless they clearly indicate a new tendency in river flow. It is not enough to cite a few isolated cases. In a period of, say, two hundred years, there must be a record year for high and one for low water. Is there any reason why it might not occur this year as well as earlier? There must be clear evidence of permanent change before any conclusion can be legitimately drawn. In two instances such a tendency may possibly be claimed, the Ohio at Pittsburg and the Connecticut at Holyoke, which show, in the past few years, a greater frequency of high waters than for some years previously.^a To whatever extent this may be true, it is certainly not due to deforestation. The change in the forested areas on the water-sheds of either of these streams has been relatively very slight in the past twenty years. The great inroad into the timber of the upper Ohio took place many years ago. Since that time many cleared areas have grown up to timber while new areas have been cut. The change one way or the other, in recent years, compared with the total area, is altogether insignificant. The Connecticut watershed above Holyoke has a greater forested area than it had forty years ago. This is due to the abandonment of former farms which, in many instances, have grown up to timber. It is doubtful if the recent cutting in the White Mountains offsets this, and, so far as snow melting is concerned, what cutting there has been is certainly in favor of uniformity of flow.^b

^a In the period of thirty-four years from 1874, the Ohio River at Pittsburg rose above 15 feet on the gauge 148 times. In the first half of this period, 68 of these freshets occurred and 80 in the second half. The mean for the first half was 19.3 feet and 20.2 feet for the second half. The mean of the lowest waters of the first half was 0.3 foot and 1.6 feet for the second half. In Transactions, American Society of Civil Engineers, Vol. LVIII, p. 31, is a twenty-year volumetric record of the Connecticut, which indicates somewhat higher high waters during the last half of the period. But in this case, as at Pittsburg, higher low waters are also indicated. In fact, in both cases, the greater runoff in the later period was clearly due to greater precipitation.

^b I have seen in the last few years abandoned farms (abandoned because of their unprofitability) on the western slopes of the Allegheny Mountains, which are almost impenetrable forests of thrifty trees suitable for making mine posts and telegraph poles. There are, of course, large areas subject to fires at intervals of a few years, but that they are subject to such recurrent fires is

The records of some American rivers have been given. It is, of course, in Europe that one would expect to find more definite data, because of the longer periods through which records have been kept. The histories of several of these streams have been examined without finding any confirmation whatever of the forestry theory. The floods on the river Seine, for example, show greater heights in the sixteenth century than in the nineteenth. The most exhaustive investigation of the records of European rivers, however, is that of the Danube, the great river of central Europe, recently made by Ernst Lauda, chief of the hydrographic bureau of the Austrian Government. The years 1897 and 1899 brought destructive floods to the valley of the Danube, that of 1899 being particularly severe. M. Lauda prepared an exhaustive report upon this flood, published in 1900, accompanied by elaborate maps and tables and a searching analysis of the climatic and other conditions. In his "concluding remarks," M. Lauda traces the history of the Danube floods for eight hundred years, including in all 125 floods. His conclusions are that floods were formerly just as frequent and as high as they are in recent times, and that the progressive deforestation of the country has had no effect in increasing them. In fact, the records of the flood of 1899, which was a summer flood, produced almost entirely by rain, showed that it was severest on those very parts of the watershed that were most heavily forested.

At the Tenth International Congress of Navigation, held at Milan in 1905, one of the four questions appointed for discussion was the very one here under consideration. Papers were presented by representatives from France, Germany, Italy, Austria, and Russia. While all the writers heartily favored forest culture, the opinion was practically unanimous that forests exert no appreciable influence upon the extremes of flow in rivers. It appears, therefore, that European experience does not support the currently accepted theory.

So much for the evidence supplied by the records in this country and abroad. The constantly reiterated statement that floods are increasing in frequency and intensity, as compared with former times, has nothing to support it. There are, it is true, periods when floods are more frequent than at others, and hasty conclusions are always drawn at such times; but, taking the records year after year for considerable periods, no change worth considering is discoverable. The explanation of these periods of high water, like the one now prevailing, must, of course, be sought in precipitation. That is where floods come from, and it is very strange that those who are looking so eagerly for a cause of these floods jump at an indirect cause and leave the direct one entirely untouched. In the records of precipitation, wherever they exist, will be found a full and complete explanation of every one of the floods that have seemed unusually frequent and severe in recent years. A few examples will be cited:

The great Kaw River flood of 1903, which wrought such havoc in Kansas City, was caused by a wholly exceptional rainfall over nearly all the watershed of that stream. In the first three weeks of May, 1903, more than the normal amount (4.5 inches) for the entire month fell. This was followed in the next five days by 3.4 inches, and upon this was piled 4.7 inches in the succeeding five days, by which time the flood had crested.

In the flood of 1906 in western Washington, which did enormous damage and stopped railway traffic for upward of two weeks, the crest of the flood occurred about the 15th of the month. The month of October had been very wet, and the ground and forest storage was exhausted. In the first half of November, 25 per cent more rain fell than in the normal for the entire month, and of this about one-half came on the 13th, 14th, and 15th.

In the flood season of 1905, on the watershed of the upper Mississippi, there fell in the month of April above Pokegama Falls 2.55 inches; in May, 4.95 inches; in June, 8.03 inches, and in July, 6.88 inches; a total of 22.41 inches. The normal for the entire year is 26.5 inches.

proof of their rapid production of fuel which means twigs and leaves in great abundance. (Col. Thomas P. Roberts, Pittsburg, Pa.)

The forest area in Vermont is probably 10 per cent greater than forty years ago. Of course the quality of the forest is inferior, but that has no effect on the watershed. (Arthur M. Vaughan, state forester.)

Farms in the Connecticut Valley are among the richest in the State (New Hampshire) and have been less abandoned than elsewhere. There has been, however, a goodly acreage, very probably amounting to 25 per cent, which was cleared land in 1850, and which at the present time has reverted to forest, much of it excellent white-pine forest. (Philip W. Ayres, forester.)

In the record-breaking flood of 1907 in the Sacramento Valley 88 per cent of the normal for the month of March (based on twenty-one years' observation) fell in three days (17-19), and on one day the precipitation ranged from 5 to 8 inches at the different stations.

In the extraordinary flood of May and June, 1908, in western Montana, the precipitation for May, at four selected stations, was 6.5 inches and for June 4.2 inches. The greater portion of this fell late in May and early in June. The normal for May is 2.6 inches and for June 2.3 inches.

Similar conditions prevail in every great flood, and the true explanation is found in them and not at all in the presence or absence of forests on the watersheds. Whether the forests are in any way responsible for the precipitation, itself and so, indirectly, for the floods, brings up the third of the foregoing general propositions, viz., that forests do increase precipitation. However strong may be the popular belief in this theory, there is nothing in the records of rainfall to give it substantial support. The author has had occasion, in connection with his official work, to compare the rainfall records in the northern half of the United States from the Atlantic to the Pacific, often with this particular point in mind, and he has never found anything to indicate a change. So far as he has examined European records the same result holds, and he believes it to be true the world over, except where climatic changes have resulted from causes entirely disconnected with the operations of man in changing the face of nature. In fact, the claim that forests increase precipitation (about 10 per cent, according to Mr. Pinchot), leads to some contradictory results in the forestry argument. Coincident with our recent high waters, which are attributed so largely to deforestation, there has been an increase in precipitation, where there should, apparently, have been a decrease.^a It is evident that where one rule applies the other fails. So, likewise, it is held that forests are necessary to protect mountain slopes because of the greater precipitation prevailing there; yet the forests are said to increase this precipitation materially.

There is really very little, theoretically, to support the claim that forests insure precipitation. It is said that the cooler status of forest areas condenses moisture and induces precipitation; but if this were so in midsummer, when the least precipitation falls, how about the rest of the year when no such difference exists, but the reverse, if anything? Take, for example, the great forests around the source of the Yellowstone. During the period when the bulk of the precipitation falls the temperature of the forests can not differ materially from the outside, and it is impossible to believe that the forest exercises much influence upon the snowfall.

The fact that these high areas are generally wooded is frequently cited to prove that forests produce the higher rates of precipitation which also prevail there. But would it not be more reasonable to say that the forests flourish there because of the higher precipitation, and that the latter is due to the elevated situation and consequent lower temperature? Is not this, in fact, the reason why precipitation is nearly always greater upon the hills than upon the neighboring lowland? The mountains are nature's wine press by which she extracts from an unwilling atmosphere the elixir of life for the hillsides and the valleys below, and she does this whether the forests have been cut away or not.

In one respect, and a very important one, forests diminish precipitation, and that is in the deposition of dew. Dew is essentially an open-country phenomenon, where the radiation of heat from the earth's surface is unobstructed. Clouds or high cover of any kind, and also wind, interfere with this process and prevent the dew from gathering. It collects in full strength on low shrubbery, to a less degree on small trees, as in orchards, and penetrates for short distances under forest cover. In the heart of the native forest of full-grown timber, however,

^a As a step in the crescendo of gloomy forebodings upon this subject, that have filled the periodicals during the past twelve months, the following from the September Scrap Book is the very latest: "When our forests are gone the streams will dry up, the rivers will cease to run, the rain will fall no more, and America will be a desert." Considering how large a percentage of our forests has already disappeared, the extraordinary rains in all parts of the United States during the past year are not exactly in line with this dismal prophecy. If one were to judge from the records of the past few years only, he must conclude that deforestation is increasing rainfall.

dew is practically unknown. The quantity deposited in the open country in a single night is quite large under favorable conditions, leaving the effect on shrubbery and on the ground of a considerable shower. As it gathers in greater or smaller quantities on every clear, still night in the eastern sections of the country, except in the colder season of the year, the total quantity must be quite large.^a

One authority holds that dew does not come entirely from the air, but in part from the ground. It is said that water which in the daytime passes from the ground and plants into the air is prevented from doing this at night, because the air can not receive it, and therefore it gathers in visible form on the ground and vegetation; but if this were true, it really makes no difference in the benefit which comes from the dew. Whether the low temperature due to radiation causes a deposit of moisture from the air or prevents the air from absorbing moisture which it otherwise would, the result, so far as the ground and vegetation are concerned, is practically the same.

This may be as good a place as any to note one important characteristic of precipitation, and that is its tendency to move in cycles. It is well known that dry years often follow each other for long periods with great regularity, and that these are succeeded by wet periods. Take the region of the upper Mississippi reservoirs where the normal precipitation, based upon twenty-one years' observation, is 27.1 inches; in the ten years 1886-1895 this normal was exceeded only once; in the succeeding ten years the record fell appreciably below it only once. Omitting these two years, the mean for the two periods of nine years was 24.7 and 30 inches, respectively, an average yearly difference of nearly one-fifth of the normal. Following the well-known law that the percentage of run-off increases and diminishes with the precipitation, the disparity between the run-offs for the two periods was greater still.

This phenomenon is also admirably illustrated in the rise and fall of the levels of the Great Lakes, for these immense storage reservoirs not only absorb and distribute annual variations of run-off, but equalize to a large degree the variations from year to year. During the period of the eighties there was a general rise in the lake levels, except Superior, and many people ascribed this fact to deforestation, which allowed the water to find its way more quickly into the Lakes. During the nineties there was a period of general subsidence, occasioning considerable anxiety, and it was frequently asserted at that time that this was due to deforestation, which was drying up the streams. For some years now the Lakes have been rising, Ontario being the highest in forty years; and with another wet year the levels will almost reach record heights.

The long record of the Danube floods already referred to is another example. Almost invariably high floods would follow each other for several years in close succession, and then would come long intervals of ordinary high waters.

These periodic changes are not, of course, due at all to the presence or absence of forests, for they occur just the same whether forest conditions remain unchanged or not. It is an order of nature not at all understood, but nevertheless fully established as a fact. Just now we are in an era of high precipitation and consequently of high waters. There is a disposition to "view with alarm" these exaggerated conditions. Rarely does one stop to think how far better it is to the country to have these wet periods, even with all their floods, than the dry periods that will surely follow. A single dry year may cause more loss to the country through the shrinkage of crops than the floods of an entire cycle of wet years.

Related to the subject of precipitation is that of evaporation as affecting the quantity of water that remains upon the ground. Generally speaking, the surface evaporation in summer should be greater in the open than in the forest because of the more direct action of the sun and wind; but in the height of summer the forests arrest precipitation to such an extent in the leaves and humus that more of it escapes through evaporation than in the open. The effect of

^a The author has never seen any data as to the actual quantities of dew deposited in different localities and conditions, and hopes that the discussion of this paper may bring some to light. He has, however, vivid recollections on the subject when, as a lad on a dairy farm, it was his unlucky lot to go barefooted after the cows every morning without waiting to see whether the sun was going to shine or not. He knows from experience how near zero the dew point can get, and how wet dew is; and also that the warmest place in the world at such times is where a cow has lain all night, and next to that the dry precincts of the tall woods.

forests upon evaporation through the medium of their leaves finds its counterpart in the similar action of the growing crops that overspread deforested areas. As already pointed out, the forests of the mountains increase the evaporation from snow very materially.

Where the balance lies among all these conflicting influences affecting precipitation and evaporation it is impossible to say, and when the records are examined it must be admitted that they afford no answer. So far as the researches of science have yet determined, the presence or absence of forests cuts no figure in climatic conditions. These depend upon causes of far greater magnitude and are influenced, if at all, only to an insignificant degree by the operations of those who occupy the planet.

The fourth proposition of the forestry argument is that forests are necessary to prevent erosion on steep slopes and the consequent silting of reservoirs and watercourses below. Here again there is the same deficiency of evidence to support the theory that has characterized the three propositions already considered. The author has been unable to find anything to confirm it. In his observations, embracing pretty nearly all varieties of timber land in the northern two-thirds of the United States, he has still to see a single example where the mere cutting off of forest trees leads to an extensive erosion of the soil. Almost invariably, and it may be said always except in very unusual conditions, a soil that will sustain a heavy forest growth will immediately put forth, when the forest is cut down (or even burned down), a new growth, generally in part different from the first, but forming an equally effective cover to the soil. The only approach to an exception to this rule that he has observed is in some of the high mountain forests where the soil is extremely thin and weak and the action of nature in producing vegetable growth is slow. In the forest areas of the East, the growth that follows tree cutting—consisting not only of new trees, but of briars and small brush of every description—accumulates very rapidly and forms a more effective mat against erosion than the original forest itself and equally effective in storing water. Such low growths have also a better effect upon snow melting, because they give both wind and sun freer play. Certainly the ground in a forest under culture, with the débris raked up, is more easily eroded than that of a slashing or second-growth area, or even good meadow or pasture. A forest soil unprotected by forest débris is almost as erosive as a field under culture.

The increased erosion of the soil, of which so much is heard, does not result from forest cutting, but from cultivation, using that term in its broad sense to include all of man's operations for the occupancy and utilization of the ground from which the forests have been removed. It is the "breaking of the soil" that leads to its erosion by the elements. Roads and trails are one of the great sources of erosion in hilly countries, but plowing and tilling are the principal causes. The question is not one of forests in the first instance, but of how far the cultivation and occupancy of the soil can be dispensed with. Even on steep mountain slopes, where erosion and ruin have resulted, the effect is often due to the clumsy and injudicious work of the husbandman who uses no judgment of cause and effect in the way he exposes the soil to the force of the storms. The successful cultivation of hillsides in every quarter of the globe is an everlasting refutation of the argument that forests are necessary to protect the face of the earth wherever cultivation is practicable. Some classes of cultivated vegetation, like the well-knit turf of meadow or pasture, are a better protection against erosion than any ordinary forest cover. That there are sections of the country where erosion of the soil is much more rapid than in others under similar conditions is perfectly true. This is especially the case with certain districts in the Southern States, and very likely forest protection is there better than any other; but it is still true that the problem of control of soil erosion on cleared lands is essentially a problem in cultivation. It is not so much the absence of the forest as it is the cutting of roads and ditches, the upturning of the soil, and the various kindred operations of man that quicken the run-off and increase the surface soil wash.

The oft-repeated assertion that, owing to the cutting off of forests, our rivers are shoaling up more than formerly may be challenged absolutely. There is nothing in our river history to support it except in a few instances, like the Yuba River in California, where extensive hydraulic or similar operations have produced vast changes. It is exceedingly doubtful if it can be established by any evidence worthy of the name that the streams of the Mississippi basin are more obstructed by sand bars than formerly. The author's observation of

upward of twenty years and inquiries from many sources fail to disclose any such evidence. It would not, indeed, be surprising if some such result were noticeable, for it would naturally seem that the cultivation of the soil has facilitated to some degree the wash into the streams. If this is the case, however, the rivers do not show it. They have a way of distributing their burdens so as to meet their necessities and, except in rare cases, they do not shoal appreciably more than formerly.^a

The distinction between erosion actually resulting from cultivation and that assumed to result from timber cutting is important to keep in mind, for it fixes the burden of responsibility where it belongs. It shows that this erosion or soil wash can be reduced only by the elimination or control of cultivation, and the question at once becomes that of the extent to which such control or elimination is practicable. For example, it is insisted that the suggested reservoir system of the Ohio, to be referred to later on, will be absolutely dependent for its integrity and permanence upon keeping the watersheds above them covered with forests. But it is understood not to be the policy to include in the proposed forest reserves any lands that are fitted for agriculture.^b As elsewhere pointed out, that portion of these areas which is not reduced to cultivation will not be subject to erosion more than at present by the mere fact of cutting off the timber, for the natural growth on logged-off lands is just as good a protection as the forests themselves. If the agricultural tracts are still to be left open for occupancy, the source of sediment remains uncurbed and the whole argument for forest reserves, on the ground of protecting the reservoirs from sedimentation, falls to the ground.

Some reference should be made to the real significance of the alarming reports which have been put forth concerning the washing of our soils into the sea. Over and over during the past year has the statement appeared that 1,000,000,000 tons of our soil is annually carried by our rivers into the ocean. This figure itself is quite conservative, but the conclusions drawn from it are not at all so. Taking the results of silt observations on the Mississippi River and its tributaries for 1879 and applying the Missouri rate to all western streams outside the Mississippi basin and the Ohio rate to all eastern streams outside the same basin, a total of about 1,100,000,000 tons is indicated. But 1879 was a low-water year in the Mississippi basin and the quantity for average years may probably be 1,500,000,000 tons and for extreme years 2,000,000,000 tons.

Let us look these prodigious quantities squarely in the face and see what they mean. Where does this enormous volume of soil come from? Is it, as one might infer from published references to the subject from our cultivated fields—an annual toll laid upon the precious fertility of our agricultural lands? Not at all. Only a very small proportion comes from this source. Possibly half of the total quantity of sediment goes down by the Mississippi. All authorities agree that the greater portion of this comes from the Missouri. From computations which the author has made he believes that fully two-thirds of it comes from that source. The observations of 1879 indicate that five times as much sediment comes from that stream as from the Ohio. But where does the Missouri get it? Almost entirely from the most useless areas of land with which any country was ever afflicted. The barren Bad Lands are the principal source. Much comes from the mountains; much from the sand hills; very little, relatively, from cultivated areas. Of the balance of the soil wash of the United States, by far the greater portion comes from

^a The absurd length to which this erosion argument has been carried is well illustrated by the remark made in a recent address by one of the officials of the Forestry Service: "This energy (of running water) is expended in rolling along stones and gravel to finally build up the mouths or beds of the great rivers. Next year there will be a bill introduced in Congress providing a forest reserve in the Appalachian Mountains, so that the rocks from these mountains will be kept from the Mississippi River!"

^b Among references to the intention not to absorb agricultural lands in the areas conserved by the reservoirs is the following from A. F. Horton, Assoc. M. Am. Soc. C. E., in Engineering News, June 11, 1908: "The reader should not lose sight of the fact that the conserved area is not rendered unfit for cultivation or other use, but that only a small portion of the conserved area (that covered by the reservoir) is so utilized that its value for cultivation is destroyed."

other similar sections of the West, where the streams carry enormous loads of sediment. The entire Colorado system is even more distinguished in this respect than is the Missouri. The same is true of the Rio Grande, the Pecos, and the upper courses of the Arkansas and Red. Even the streams of the Great Interior Basin are heavy silt bearers, and the same is true of many of the streams of the Pacific coast. The streams flowing into Puget Sound are heavily laden with silt at certain portions of the year, and the great Columbia bar is impressive evidence of the vast burden of sediment which that mighty river has carried to the sea. Nearly all of the annual load carried by these streams is entirely unaffected by anything which man has done. It is the regular natural carving down of the hills and building up of the valleys and estuaries below.

The eastern streams are clear and sediment-free compared with those of the West; but even in these a large portion of their sediment is eroded from the gorges and canyons of the hills and mountains, which will continue to wash away as long as the rivers flow. This particular class of erosion, on both eastern and western rivers, is far less objectionable than one is led in these later days to believe. Has it not from the beginning been one of the most beneficent operations of nature? Are not the richest lands in the world—the river bottoms and deltas—built up in this way? To a very great extent the irrigated lands of the West are composed entirely of the débris from the mountains and the bad lands. Even to-day this tribute from the highlands is of great value. The periodic enrichment of the Ohio bottom lands and similar tracts in hundreds of other places is of the highest economic importance. The soil-laden waters of irrigation in the spring, though sometimes injurious to the growing crop for the time being, are on the whole extremely beneficial. The damage from sediment is not in its injury to the lands ordinarily, but to ditches, canals, reservoirs, and similar works. On the whole it is, and always has been, a benefit to the lowlands. Even that portion carried out to sea builds up deltas and surely, though slowly, extends the habitable area of the globe. Not alone in the resources of water and timber, but in the perpetual renewal of soil as well, has the valley said to the mountains throughout the world's history: "I will lift up mine eyes unto the hills from whence cometh my help."

Sediment of this character, except when accompanied by alkaline salts or other similar ingredients, is not injurious to domestic supply. The water of the Missouri River is one of the healthiest drinking waters in the world in spite of the fact that it is one of the muddiest.^a

The proportion of soil wash that comes from cultivated fields is really very small compared with the enormous total that the rivers carry away. Heavy rains undoubtedly wash farm soils a great deal, but this erosion is in large part a transfer from one spot to another and not an absolute loss. The history of the old Ohio Canal reservoirs indicates very little filling in the sixty-six years that they have been in existence. According to the chief engineer of the Ohio state board of public works, it is scarcely appreciable in some of the reservoirs, and in none does it amount to as much as 6 inches, or one two-hundredths of an inch per year from the tributary watershed. Yet these reservoirs are surrounded by rich agricultural lands. The silt observations on the Ohio in 1879 indicate only a little more than one six-hundredths of an inch over the entire watershed; but this, it is true, was a year of light rains.

It is readily seen that the formidable danger of which so much has been written of late becomes quite harmless as to quantity when it comes down to the individual farm. The harm is probably not so much in the quantity of soil actually lost as in the fact that the soil may be leached of some of its more important ingredients. The evil is one which can be controlled only by better methods of farming, whereby the surface waters will be restrained from eroding the soil; but even these measures have their adverse side, for when heavy rains prevail for a long time it is more important to the farmer to get the water off his land than it is to save a little soil. Most of the soil will stop on lower ground and not be wholly lost, but if the water is not gotten rid of the crop may be ruined.

^a The late J. B. Johnson, M. Am. Soc. C. E., used to say, in extolling the virtues of Missouri River water, that it was the most perfectly filtered water in the world; with this difference, however, that in the ordinary case water is run through the filter, but here the filter is run through the water.

The caving of the banks of our great rivers is constantly cited as an example of soil loss on an enormous scale, and it is asserted that this condition is worse now than formerly. The Mississippi and Missouri rivers, practically alike in this respect, are the two most prominent examples. The author will consider briefly the case of the Missouri because he has had a long and intimate acquaintance with that stream from its mouth to its source.

It may be stated by way of refutation that the actual condition of this stream to-day is better than before settlement began in its valley, except that possibly the low-water flow is slightly diminished to meet the demands for irrigation. The stream is not "constantly becoming more and more savage," as a recent writer asserts. On the other hand, its natural savagery is much restrained. Probably 100 miles of its banks are protected; snags and drift heaps are largely removed; considerable bottom land has been reclaimed and turned to industrial use; floods are no greater than they used to be, and navigation is safer and easier. Navigation has ceased, not because the river has deteriorated, as is commonly asserted, but because the natural difficulties peculiar to this stream are so great and so hard to overcome that boats can not live and do business at the same rates at which railroads transport freight.

That the river is a most destructive one to the bottom lands along its course is only too true; but the character of its destructive work is generally misunderstood. The writer just quoted states that the river carries away annually 8,000 acres of bottom land within the limits of the State of Missouri alone. The total acreage of these lands is about 640,000. If this statement were true, more than the entire area would have been carried away since the voyage of Lewis and Clark, and if the process had been continuous since Columbus discovered America the river to-day would be flowing in its original channel in the solid rock, 75 to 90 feet below the present surface. As a matter of fact, there is more soil in the valley to-day than there was at the date of either of these events. Taking an average for a considerable period, none of the bottom land is lost. It has always been slowly rising through accretion. The bank caving is only a transfer from one point of the shore to another. For every dissolving bank there is a nascent bar. Where steamboats ran last year willows may be growing this, and next year the farmer may be planting his corn. The havoc wrought concerns the individual owner, but not the valley bottom itself. The cruel losses attract attention; the unobtrusive gains do not; but the account always balances itself. The harm done is first to the individual whose possessions are swept away, and second to the community through paralysis of development, depreciation of values, and the holding back of this natural garden spot from becoming what it ought to be. The evil is a very real one, and the author has long endeavored, though without success, to secure provision in the river and harbor bill for its amelioration.^a Great as the evil is, however, it is not at all in the nature of an actual loss of land to the valley.

It must be clear from the foregoing that the bottom lands of the Missouri add nothing whatever to the total quantity of sediment that passes out of the mouth of the stream, for these bottoms have been increasing rather than diminishing in quantity. Likewise, the Mississippi bottoms contribute nothing to the volume of sediment that is carried into the Gulf of Mexico. It all comes from the uplands, far and near, but principally from the more remote and hilly regions. This load is in the nature of through traffic. The local freight picked up from a caving bank is mostly discharged at the next station. It follows, therefore, that if the banks of these streams were revetted from the Gulf to Pittsburg, the Falls of St. Anthony, and the mouth of the Yellowstone, the quantity of sediment passing into the Gulf would not be diminished a particle. Such revetment would nevertheless be of the very highest value, if it could be made to hold, for it would give permanence to the banks, security to riparian property, and would largely prevent bar building by training the river into a regular channel and relieving it of everything except its through load of sediment.

The bank-caving problem of these valleys is unaffected in any appreciable degree by the influence of forests or cultivation on the watersheds, and can not be solved or materially assisted by any practicable changes in these conditions. The problem is strictly a local one, and the remedy must be a local one. Even if it were possible to bring the waters down from the uplands perfectly clear, it is not at all certain that the effect upon the bottom lands would not be injurious rather than beneficial; for then the caving soil, instead of being quickly depos-

^a Transactions American Society of Civil Engineers, Vol. LIV, p. 336.

ited again, would in part be carried out to sea, and the bottom lands, unless protected, would be gradually eaten away.

In addition to the four main propositions discussed above, a few subordinate features of the question will now be considered.

A feature of the Forestry Service which is generally overlooked is the possible effect of culture upon the bed of humus, so much relied upon in these discussions to prove the restraining action of forests upon run-off. Mr. Pinchot, in his statement to the Judiciary Committee, said:

"The effect of a forest on a steep slope is to cover that slope with leaves, rotten and half rotten sticks, and other mechanical obstructions, which prevent the water from running below as rapidly as it would otherwise."

It is understood that the forest policy is to keep this litter cleared up as a measure of fire protection, and one frequently sees in articles on forestry photographs of the typical forest culture in which the ground is thoroughly cleaned up. The result must be to diminish proportionately the retentive action of the forest bed and to increase its liability to erosion. In the light of the foregoing discussion fire protection is of much greater importance than the retentive effect of the forest bed on the run-off. The remarkable degree to which the forest bed will dry out in prolonged drought, making it one vast tinder box, supports this conclusion, and is another proof of the extreme desiccating effect of forest growth upon the soil.

It often escapes attention, except with those who are in the woods a great deal, that the water establishes little channels through the débris where the latter is of long accumulation and somewhat permanent in character. Such débris does not in reality offer so great an obstruction to flow as one would suppose, and as would be the case if its condition underwent frequent change.

The statement is constantly met that forests are very efficacious in the protection of river banks from undermining and steep slopes from sliding. The exact reverse is the case. As every river engineer knows nothing is more disastrous to a river bank on an alluvial stream than heavy trees. This is due partly to the great weight, but in large part to the swaying effect of the wind and the enormous leverage of the long trunks which pry up the ground and facilitate the tendency to undermining. One of the regular policies of river control is to cut down these trees for a distance back from the edge of the bank wherever complications with private ownership do not prevent. Snags and driftwood in the channels have always been among the most serious obstacles to navigation on streams flowing between forest-covered banks. Likewise where railroad or highway grading cuts the skin of unstable mountain slopes, the presence of large trees immediately above tends powerfully to loosen the ground and cause it to slide; and in such cases it is necessary to cut down the timber. Far better than forest trees on river banks are thick growths of willow, alder, or any of the smaller close-growing shrubs; and on side hill slopes either such shrubbery or a good turf.^a

In the current discussion a great deal is made of the fact that mountain slopes are "quick spilling," the deduction being that they therefore are more productive of floods. This is quite contrary to the fact. It is perfectly true that more rain falls on the hills than on the lowlands, that a greater percentage of rainfall runs off from steep than from flat slopes, and that it runs off more rapidly; but it does not follow at all that these conditions produce greater floods. A mountain stream carries off the water within its banks a great deal faster and more safely than a similar stream in the lowlands. The banks are almost always stable and the bottoms rocky or composed of heavy gravel or boulders; in fact, floods do less harm on such streams than on any others. In the lowland, where the streams have smaller slopes and unstable banks, much smaller run-off produces greater floods and more destruction. Moreover, nature to a large degree adapts streams to the work required of them. The channels

^a The following testimony before the Board of Consulting Engineers, Panama Canal, is to the point (Report, p. 329):

Question by Mr. Welcker: Mr. Chairman, I would like to ask if Mr. Dauchy thinks that vegetation prevents the sliding?

Mr. DAUCHY. My experience has been the reverse; I have stopped sliding hills by cutting off the vegetation. The weight of the timber on a sliding slope aids materially to assist the sliding.

Mr. WELCKER. Does not the vegetation diminish it?

Mr. DAUCHY. If you could get a grass-covered slope it would help to diminish it.

of the tributaries of the Ohio have been carved out through long ages to carry in safety the average flood flow. Area for area of watershed, their cross-sections are much larger than those of streams in climates of less rainfall. The normal section of the Ohio at Wheeling is over 2 square feet for every square mile of watershed, while that of the Kaw River at Kansas City is less than one-third square foot per square mile. It is therefore wholly erroneous to conclude that the streams of these mountains are more subject to over-bank freshets than those of the lowlands or that the freshets themselves are more destructive. Considering the conditions growing out of settlement the reverse is unquestionably the case.

There is one other consideration of prime importance in this forestry argument, and that is the fact that no possible development of forestry can increase the present percentage of forest-covered areas. At least as much ground as is now devoted to agricultural purposes must continue to be so used. The utmost admissible expansion of national forests will never require a greater area than is now occupied by forests and second growth or logged-off lands, which, so far as run-off and erosion are concerned, are just as effective as the virgin forest itself, and more effective than will be the groomed forest of the new régime. There may be a shifting of areas devoted to forests, but possible expansion, compared with the present area, is so small that its influence upon the great rivers, even admitting the full force of the forestry argument, would be wholly inappreciable.

The fact just dwelt upon should make us thankful that the forestry theory as to the stream flow is not correct. Whatever the value of forests we can not have them everywhere, and by far the greater portions already cleared away must always remain deforested. If this fact of deforestation has brought with it in greater degree than of old the calamities of high and low waters, then, indeed, we are in an unfortunate case. But it has not done so. Nature has decreed no such penalty for the subjugation of the wilderness, and on the whole these natural visitations are less fréquent and less extensive than they were before the white man cut away the forests.

In summarizing below the foregoing argument, the author would be particularly careful to guard against sweeping assertions in any of his conclusions. He well understands how little the subject is capable of precise demonstration. Snow, for example, does not always fall, even in the open country, under the influence of the wind, or it may fall in a wet condition that keeps it from drifting. Altitude comes in with its lower temperature and modifies the general result. There is a vast difference between a northern and a southern exposure even with the same slope and topographical conditions. Precipitation scarcely ever occurs twice alike on the same watershed. The combination of flow from tributaries is never the same in any two floods, and there is an endless variety of conditions that must qualify our rules and make us cautious in making claims in a matter of this kind. The author objects solely to the contrary course pursued by many forestry advocates—to the extreme claims that forests exert a regulating influence upon stream flow in times of great floods or extreme low water in our larger rivers. These claims stand to-day absolutely unproven. The difference between past and present conditions is not great. One influence offsets another with such nicety that the change, if there is any, is hard to find. The "delicate balance" maintained by nature where man has not cut away the forests is replaced by other balances equally delicate and efficacious in the drainage of lands, the growing of crops, and the deposition of dew.

In the following seven propositions the author sums up the arguments presented in the foregoing pages:

(1) The bed of humus and débris that develops under forest cover retains precipitation during the summer season, or moderately dry periods at any time of the year, more effectively than do the soil and crops of deforested areas similarly situated. It acts as a reservoir moderating the run-off from showers and mitigating the severity of freshets, and promotes uniformity of flow at such periods.

(2) The above action fails altogether in periods of prolonged and heavy precipitation, which alone produce great general floods. At such times the forest bed becomes thoroughly saturated, and water falling upon it flows off as readily as from the bare soil. Moreover, the forest storage, not being under control, flows out in swollen streams, and may, and often does, bring the accumulated waters of a series of storms in one part of the watershed upon those of another which may occur several days later; so that, not only does the forest

at such times exert no restraining effect upon floods, but, by virtue of its uncontrolled reservoir action, may actually intensify them.

(3) In periods of extreme summer heat forests operate to diminish the run-off, because they absorb almost completely and give off in evaporation ordinary showers which, in the open country, produce a considerable temporary increase in the streams; and therefore, while small springs and rivulets may dry up more than formerly, this is not true of the larger rivers.

(4) The effect of forests upon the run-off resulting from snow melting is to concentrate it into brief periods and thereby increase the severity of freshets. This results (a) from the prevention of the formation of drifts, and (b) from the prevention of snow melting by sun action in the spring, and the retention of the snow blanket until the arrival of hot weather.

(5) Soil erosion does not result from forest cutting in itself, but from cultivation, using that term in a broad sense. The question of preventing such erosion or soil wash is altogether one of dispensing with cultivation or properly controlling it. The natural growth which always follows the destruction of a forest is fully as effective in preventing erosion, and even in retaining run-off, as the natural forest.

(6) As a general proposition climate, and particularly precipitation, have not been appreciably modified by the progress of settlement and the consequent clearing of land, and there is no sufficient reason, theoretically, why such a result should ensue.

(7) The percentage of annual run-off to rainfall has been slightly increased by deforestation and cultivation.

If the foregoing propositions are correct they enforce two very important conclusions—one relating to the regulation of our rivers and the other to forestry.

It follows that no aid is to be expected in the control or utilization of our rivers, either for flood prevention, navigation, or water power, by any practicable application of forestry. Remember always that it is the extreme of flow, not the medium condition, that controls the cost of river regulation. It is the floods and low waters that measure the cost. Any scheme of control that is not based upon these is worthless. This proposition need scarcely be urged upon the experienced engineer. For himself he would never place any real reliance upon forestry. Called in consultation, for example, in the problem of protecting the city of Pittsburgh from floods, he would be bound to take as his measure of the problem the highest recorded flood on the river with a good factor of safety on that, and then figure out by what methods—artificial reservoirs, levees, raising of grades, or clearing the river channel of artificial obstructions—he would obtain the desired relief. He would not dare, as the physician in the case, to advise his patient that he could dispense with or lessen in any degree the application of the remedies proposed, nor save one dollar of the cost, by anything that might be done in reforesting the watershed of the rivers themselves.^a

In like manner no engineer could honestly advise lowering in height by a single inch the levees of the Mississippi, because of any possible application of forestry to the watershed of that stream. And again he could not advise that forestry development would lessen in any degree the cost of improving the rivers for low-water navigation. Engineers fully understand their responsibility in these matters. But great engineering projects can not be carried out without money, and the people will not give the money unless convinced of the necessity and wisdom of the plan proposed. So long as there is apparently some easier and simpler plan, some panacea, no matter how nebulous or unproven, that offers a way out without the expenditure of so much cold cash, they will be backward in voting money, and the counsel of the engineer will be of no avail,

^a Possibly the author is too positive in this opinion. He finds that, in one case at least, the city of Williamsport, Pa., reputable engineers have advised reforestation of mountain slopes as a protection against floods. The statement of "an eminent authority" was cited with approval to the effect that "four-fifths of the precipitation is detained by the surface of the ground" under forest cover. But here, as in all these assumptions, the rule applies only to the average condition. The point is overlooked that in periods of heavy precipitation the retentive capacity of the forest bed becomes exhausted. If the city of Williamsport is relying upon this advice it is certainly laying up for itself a season of repentance.

Hence the complete divorcement of forestry from any connection with river regulation—so far, at least, as its effect upon the cost of such regulation is concerned—will be a distinct and positive gain to the latter.

In the second place, forestry will be left to work out its own salvation without any reference to the rivers. Will not its cause be promoted by this divorce? At first thought it may seem that thereby one great argument for forestry is lost; but no argument can be of value in the long run that is not based upon truth, and the disappointment that is certain to result in the fulfillment of these hopes will do more harm than good. Forestry does not need any such support. It stands on a basis of its own, too broad and too sure to require any extraneous aid. What is this basis? The reply may be given in the beautifully appropriate phrase that occurs in the act of Congress creating the first of our national parks, "the benefit and enjoyment of the people." In the matter of benefits, forests are necessary, because they produce the most important material of construction known to man; even iron can not be excepted. From the lead pencil to the mast of a ship, from the infant's top to spacious temples and palaces, it enters into nearly every requirement of human existence. A large portion of the structures for human habitation are built of it. The land transportation of the world is closely dependent upon it, for if it were not for the railroad tie scarcely a car could run. It is only when one stops to think a little upon the unlimited adaptability of wood to human needs that its transcendent importance is borne in upon him.

In the matter of enjoyment, no other work of nature has done more for the uplifting and ennobling of the mind than these "first temples" of God. It requires no argument to enforce this assertion, particularly with him who has been reared in close companionship with the woods. Sad, indeed, will be the day, if it ever comes, when the people are deprived of this source of healthful pleasure for which no adequate substitute can ever be found.

And yet this supremely important resource in human happiness is strictly limited, and the visible supply is fast disappearing. Statistics fix the date, almost as confidently as an astronomer predicts an eclipse, when the doomsday of its final disappearance will come unless something is done to prevent. Most fortunately this material, unlike copper or iron or stone, is a vegetable product capable of self-renewal, and the supply can be kept up forever. This is what gives it extreme importance to forestry. It requires no dubious support from any other source. It fully justifies the splendid work that the Forestry Service is doing and demonstrates the wisdom of the farsighted men who are laying the foundation of our future national forests.

Let us now inquire if it will not be to the advantage of this great work to be absolutely independent of any connection with waterway development. Will it not be better in every way for forestry if it is promoted solely on the basis of producing trees for human use and enjoyment, and not at all for any supposed influence upon flow of streams? Is it really a wise move, so far as forestry is concerned, to single out the rugged and inaccessible mountains as localities where our future supply of timber must come from? The availability of forests to human needs depends very largely upon the situation in which they grow. Few people understand the exceeding importance of this matter. The converting of a forest tree into form for use involves two distinct processes, the conversion of the tree into lumber or other product and its transportation to the place of consumption. The cost of logging operations is immensely increased by the roughness of the ground. In our western forests, for example, it requires a higher grade of skill, commanding higher wages, to "lay" a tree on a steep hillside than on even ground. The losses from breakage in falling are much higher, and the difficulty and expense of getting the logs out much greater. In fact, the increase of cost runs all the way from \$1 to \$10 per 1,000, depending upon the situation. Engineering News stated the case very forcibly in regard to the Appalachian forests (though it did not have this particular thought in mind) when it said, in a recent issue, that "the cutting off of forests on the remote mountain slopes has only become possible with the high price of lumber that has prevailed for ten years past." This increase of cost represents the perpetual tax that the public must pay for timber from these regions as compared with that from the lowlands. And a great deal of it can never be gotten out at all. The poet's "gem of purest ray serene" was not more lost to human needs than are tens of thousands of noble trees in the rugged fastnesses of our mountains, east and west. Benefit? To convert them into lumber will cost more than they are worth. Enjoyment? Only the solitary hunter or mountaineer ever sees them. These are not the places to rear up forests for the good of the people.

Consider the question of transportation and take Chicago as being practically on the meridian through the center of population of the country. The rate on fir from the Cascades to Chicago is 55 cents per 100, or \$16.50 per 1,000 feet b. m. The average rate from the Appalachian forests is about 18 cents, or about \$9 per 1,000 for green oak. By a proper distribution of our forests these rates on the average ought to be brought within 10 cents per 100. In logging and transportation together, the country will tax itself on the average not less than \$10 per 1,000 for whatever supply it derives from these mountain forests as compared with what it might receive from forests more favorably located.

If it were not for the erroneous assumption that forests have a regulative effect upon the flow of our navigable rivers, would not the policy in regard to the acquisition of lands for forest reserves be quite different from that now proposed? If Congress were to vote, say, \$10,000,000 at the next session to commence the establishment of national forests by purchase, would it not be far better spent in lands where the pine, oak, cherry, and ash used to grow, in locations convenient for access by the people and in every way better adapted to their needs? States, counties, or other agencies should be required to meet half the original cost. Even if the total cost to the Government were several times what equal areas in the mountains cost, it would be far more economical in the long run. There is an abundance of land in nearly all the States, suitable for the purpose, that can be had at not excessive cost. In New England, for example, would not the development of forests in the lowlands, where in many places former cultivation has been abandoned, be far better than to buy up the difficult slopes of the White Mountains? Let there be a national forest in every county of the United States where it is practicable to create one. Let its location be carefully chosen so that its product may be manufactured and shipped with the smallest cost to the people, and serving also not only as a pleasure ground but as a stimulus to similar work by private agencies.

It will be urged that these mountain lands are worth more for forestry than for agriculture. Very true; but that would not justify their purchase if the same money would produce a better result elsewhere. "Never buy what you do not want because it is cheap." Again, it may be said that here is our only remaining timber supply in the East, and it must be saved. Except in some possible economy by the more judicious cutting under government control, it is not apparent how a forest tree that has attained its growth is going to render any greater good to humanity by being saved for the next generation than by being cut for this. There is a general sentiment current in these later years that if timber is cut off by private agencies it is wasted; but does it not find its way into common use just the same? Not as completely, perhaps, but still substantially the same. Take the combination of the Weyerhaeuser Timber Company, considered entirely apart from its economic and ethical aspects as a great trust or corporation, and solely as a preserver of our forests. With its system of fire control, its policy of holding its timber for high prices, is it not really conserving the timber for future use? To speak of such timber as being "lost" to the people, "wasted," and its acquisition as a "looting of our heritage," is as disingenuous as it is untrue. Will its lumber cost the consumer a cent more per thousand than if it were from a government reserve? It is a wholly gratuitous assumption that our timber is going to be "wasted" unless it is placed under government control. The thing of prime importance is to get new forests started. In the thirty to fifty years that our present supply will last new forests should be brought into existence all over the country. This is far more important than to buy the virgin timber of the Appalachians.

Moreover, it seems now to be considered that the virgin lands have already risen too high in price to be purchased by the Government, and that it is only the second-growth lands that can be economically acquired.^a Be that as it may, it is certain that the acquisition of such of these lands as are desirable for the strict purposes of timber production will be greatly facilitated by disabusing the minds of the owners of the impression so diligently fostered of late that the very salvation of the country depends upon their selling out to the Government. Can anyone doubt that the present course will add vastly to the purchase price?

Still another argument that may be urged is that only by linking the forests with the rivers in a way to establish their utility in maintaining navigation can the constitutional objection to the acquisition of these lands be overcome. But

^a Report of Secretary of Agriculture on Southern Appalachian and White Mountain watershed, December, 1907, pp. 8, 30, 35.

does this apply to mountain forests more than to any others? It is incontestably true that whatever restraining effect forests have upon run-off is greater upon the lowlands than upon steep mountain sides. This legal feature of the question will be referred to further on.

RESERVOIRS IN THEIR RELATION TO STREAM FLOW.

Under this heading artificial reservoirs alone are included. Natural reservoirs of various kinds exist nearly everywhere and exert a profound influence upon stream flow. The ground is the most important of these, absorbing on the average probably one-third of the total rainfall. Natural lakes are great regulators, the St. Lawrence system being the most perfect example. Forests are effective reservoirs at certain seasons. Swamps and low-lying grounds along river courses, like the great flood basins of the Sacramento and the Mississippi, are, in their natural state, enormous reservoirs which greatly reduce the flood flow of the river channels. Snowdrifts, particularly the great drifts of the mountains, are splendid reservoirs. The streams themselves have immense storage capacity; for example, the Mississippi within levees stores at least 2,000,000,000 cubic feet of water from Cairo to the Gulf, between extreme high and low water stages. All these reservoirs and many of less importance are ever active in regulating the flow of streams. Without them precipitation would flow off as fast as it arrives and our greatest floods would be magnified many times.

Here we are considering only those reservoirs constructed by man to supplement and extend the regulating effect of nature's reservoirs. If the conclusions reached in the first section of this paper are correct, forests can not be relied upon in any degree to help solve the problems of high and low water. Present conditions must be met by purely artificial means, since man has so far discovered no way of controlling the climatic conditions which govern precipitation. He can not "stay the bottles of heaven" in times of flood, nor open them in seasons of drought. He must take the water after it reaches the earth and deal with it the best he can.

The artificial reservoir is intended to attack this problem at its source. It catches and holds back the water in the near vicinity of its deposition, instead of waiting until it gathers into the rivers and then building huge bulwarks to contain it there in times of flood. It saves the stored-up supply and gives it out in the low-water season, thereby helping navigation, instead of dredging and otherwise treating the water courses to increase the low-water depth. It corrects one of the greatest deficiencies of nature by abolishing inequalities of stream flow and converting waste into utility. Theoretically, it is the perfect plan. It has always appealed to the imagination of laymen and professional alike. It has often been resorted to, and the number of reservoirs in the world is very great and constantly increasing. Hitherto they have been mainly used for power, municipal supply, irrigation, and for navigation in canals. In very few instances have they been applied to improve the navigation of large natural water courses, and in none, so far as the author is aware, for the exclusive purpose of preventing floods.

The question arises, Why are they not regularly applied to these last-mentioned purposes? The answer may at once be given that in the general case the cost is greater than the benefits to be received. This element of cost arises mainly from the absence of good sites (including dam sites as well as holding basins) and also, to considerable extent, from an interference with the purely artificial conditions growing out of the settlement of the country.

The best reservoir site is a natural lake. Such a site is already covered with water, and original conditions are not materially changed. Evaporation is not much increased by the necessary enlargement. Smaller and safer dams accomplish a given storage than for the average dry site. The question of public health involved in uncovering large areas for reservoir beds in the heated portion of the year is less serious. Everything makes these sites the most advantageous that can be found, and it may be laid down as a rule that the public good requires the utilization of every such site to the fullest possible extent.^a

^a An interesting feature of these natural reservoirs may be noted. A natural lake, wholly uncontrolled at its outlet, may have a more effective control of the outflow than an artificial reservoir of equal superficial area when full, though of far greater capacity between high and low water. The outflow from a lake can be increased only by storing simultaneously a quantity of water measured

Except in a few cases, dry sites are deficient in these advantages. Greater areas of land have to be condemned, and larger and costlier dams are required, with vastly greater danger in case of accident. Really good sites are not as abundant as one might wish, and the problem of developing storage on such sites is beset with difficulties of many kinds that greatly increase the cost.

In 1897 the author made a careful study of this question of flood control by means of reservoirs, in connection with an official investigation of the advisability of building reservoirs in the arid regions. His view of the difficulties in the way of any general application of such a system is quite fully stated in his report,^a and the following extracts are directly in point:

"It is the cost, not the physical difficulties, which stands in the way. It may be stated that as a general rule a sufficient amount of storage can be artificially created in the valley of any stream to rob its floods of their destructive character; but it is equally true that the benefits to be gained will not ordinarily justify the cost. The reason for this is plain. Floods are only occasional calamities at worst. Probably on the majority of streams destructive floods do not occur, on the average, oftener than once in five years. Every reservoir built for the purpose of flood protection alone would mean the dedication of so much land to a condition of permanent overflow in order that three or four times as much might be redeemed from occasional overflow. One acre permanently inundated to rescue 3 or 4 acres from inundation of a few weeks once in three or four years, and this at a great cost, could not be considered a wise proceeding, no matter how practicable it might be from engineering considerations alone. The cost, coupled with the loss of so much land to industrial uses, would be far greater than that of levees or other methods of flood protection. * * * The construction of reservoirs for flood protection is not, therefore, to be expected, except where the reservoirs are to serve some other purpose as well."

The above conclusions are still as applicable as they were when written. The subject has been given renewed prominence quite recently in connection with the Ohio River floods, but, before considering this particular application, attention will be given to certain reservoir systems that have been proposed elsewhere, and particularly to one already built and put in operation by the Government and which will be referred to frequently in the following pages. This is the system at the headwaters of the Mississippi—the largest artificial reservoir system in the world.

The project of converting the more important of the numerous lakes around the sources of the Mississippi and its tributaries into storage reservoirs as an aid to navigation was originally proposed by Gen. G. K. Warren, and was first put into definite shape by Colonel Farquhar, of the Corps of Engineers. The plan then embraced a large number of lakes in Minnesota and Wisconsin, but only five sites have actually been improved. The dams were first built of timber cribs, but have recently been rebuilt in concrete. The combined storage is about 93,000,000,000 cubic feet. It is about twice the mean annual run-off from the watershed, and the system is probably the only one, except the Great Lakes, which equalizes periodic as well as annual fluctuations of flow. That is, it carries over the surplus from wet years to help out in dry years, and its utility is, therefore, of the most comprehensive character. The cost of the five reservoirs is remarkably low, although it is not now possible to tell the exact cost of the present structures on account of the mixture of old and new work; but it probably does not exceed \$750,000, including a lock in the Sandy Lake dam. This is only \$8 per 1,000,000 cubic feet, or 35 cents per acre-foot on the basis

by a rise in the surface equal to that in the outlet necessary to give the increased flow. But if the artificial reservoir has reached the limit of its allowable filling, the outflow must be made equal to the inflow. If this limit is reached before or at the time of maximum run-off, then a quantity equal to this run-off must be let out of the reservoir. This contingency can never happen in a natural lake. The turning point where outflow and inflow balance each other is always after the crest of the flood has passed—in fact at the time when the diminishing inflow and increasing outflow balance each other and the lake ceases to rise. In the case of the Yellowstone Lake (140 square miles), for example, this rise, in average seasons of snow melting, continues from ten days to three weeks after the inflow has reached its maximum, and surrounding streams have subsided materially before the Yellowstone River (at the lake outlet) ceases to rise.

^a House Document No. 141, Fifty-fifth Congress, second session, p. 46.

of total capacity. It would be about twice this on the basis of the mean annual run-off from the watersheds.

A large portion of the original project has been abandoned because public sentiment did not support its continuance. The author has always regretted this backward step, as he believes in developing to the fullest extent the exceptional opportunities here offered for the storage of water. The available reservoir sites which could be cheaply improved in Minnesota and Wisconsin are sufficient to control absolutely the floods of the Mississippi within the danger line for a long distance below St. Paul and to improve the navigation of the upper river very materially, while their value for industrial purposes is almost beyond estimate.

In spite of the great and obvious advantages of this system, it has not yet received the popular approval that might be expected of it. In fact, about three years ago there arose a widespread sentiment in the community around the reservoirs that the system was, on the whole, injurious, that its disadvantages far offset its advantages, and a strong movement was organized to have it abolished altogether. For the purpose of investigating this matter a board of engineers was appointed, of which the author was a member. The board found that there was a general belief among the people below the dams that they actually increased the floods, while the people above complained bitterly of the back waters caused throughout that low country by filling the reservoirs so full. The water powers immediately below the dams complained that they were not getting even the normal flow of the stream, which was the case. Navigation interests below St. Paul have always been lukewarm in regard to the beneficial effects of the reservoirs, and the board was able to find only one steamboat captain who would make a positive statement that the boating interests derived any particular benefit from them.

Some curious results developed in this investigation. It was found that, great as the reservoirs are, conditions may arise in times of excessive precipitation that will compel them to discharge a greater quantity of water than would flow from the lakes in their natural condition. That is, they might actually operate to increase the floods if they should fill to their limit during a period of excessive precipitation. This very contingency nearly happened in the season of 1905.

In like manner, during the period of lowest water, viz., in midwinter, the reservoir gates are closed down to about 400 cubic feet per second, and the great water powers, like those at the Falls of St. Anthony, are even worse off than in a state of nature; but this drawback is not so great as might be thought, because the powers are able to utilize most of the storage when it comes during the period of navigation.

Such are some of the complications and drawbacks which are encountered in this reservoir system and which will surely be met in a system built up under less favorable natural conditions.

Nevertheless, the board found that the system was in itself a very great benefit and that the lack of appreciation of its advantages was for the most part due to ignorance of what they actually were. At the public hearing the opposition fell to pieces by the mere force of a better understanding, and it is safe to say that the system will never be abandoned, but will be extended along the lines of the original project.^a

The United States Geological Survey has recently proposed quite an extensive reservoir system for the Sacramento basin, similar in principle, though smaller in extent, to that of the proposed Ohio system. The flood problem of the Sacramento River is the most difficult in the United States in proportion to its magnitude. In fact, it seems as if it will prove impossible to convey the extreme floods of that river to the sea without extensive overflow of the bottom lands along its course. The proposition to control the floods to some extent by means of reservoirs was elaborately set forth in the paper by Messrs. Clapp, Murphy, and Martin, previously referred to. The subject had already been considered by the commission of engineers appointed by the State of California in 1904 to devise a plan of flood relief. The commission reported that, while any help from such a source must, of course, be welcome in solving the problem, it was very doubtful if such aid would be of sufficient importance to

^a The report of this board contains exhaustive data upon the system and its operation. It may be seen in the Annual Report of the Chief of Engineers for 1906, p. 1443. (Appendix AA published separately in pamphlet form.)

justify giving it much weight.^a In discussing the paper above referred to, the author stated that, while he had never visited the sites in question, it was his opinion that, as to most of them, it would not be possible to realize over one-fourth to one-third of the benefits claimed, and he based his opinion on the published records of the flood of 1907, which was the greatest in the history of the river. George L. Dillman, member American Society of Civil Engineers, in discussing the paper, flatly pronounced the whole scheme impracticable, and gave his reasons in detail for this conclusion.^b Among them, he cited in one case the great value of the lands to be flooded by the reservoirs, which he claimed were altogether more important for agriculture than for any diminution of flooding which the storage might cause in the valley below. In another case he cited the difficulty, which always suggests itself to an engineer in considering the subject, of timing the operations of the reservoirs so as to combine their effects to the best advantage, and particularly in keeping them empty in periods of prolonged precipitation, so that their capacity may be available at the critical moment. Other obstacles were pointed out, and the whole discussion presents another instance of the practical difficulties that stand in the way of any comprehensive reservoir scheme for controlling floods.

In 1903 the great flood of the Kaw River brought up the reservoir question again. Ex-Senator Burton, of Kansas, advocated the plan very urgently, stating in a speech at Kansas City that he "would have tens of thousands of reservoirs, beginning at the headwaters of the stream and coming right down." A board of engineer officers was appointed to investigate the practicability of providing against future disasters such as this flood had caused. The reservoir idea had made so deep an impression upon the public mind that a specific consideration of that feature of the problem was requested. In its report^c the board found adversely to the scheme, on the ground that its great cost, conservatively estimated at \$11,000,000, and the annual loss from the withdrawal of the necessary lands from occupancy, conservatively estimated at nearly \$600,000, would not be justified on the ground of flood protection alone. Owing to the character of the country, this last consideration was particularly strong. The only real justification of so extensive a system in a country so largely devoted to agriculture would be its use in irrigation and power, and, if it became necessary for these purposes, doubtless a portion of it would be built.

The most elaborate study of this subject ever undertaken until very recently was made by the French Government, to determine whether reservoirs could be utilized to prevent the recurrence of such great disasters as the floods of 1856 in the valleys of the Rhone and other streams. A full résumé of these studies is given in the author's report, already referred to, on "Reservoir Sites in the Arid Regions." The conclusion was the same that has been reached in every similar investigation. An interesting feature of the system then considered was that the reservoirs were to have sluices permanently open, so that it would not be possible to close them entirely. They would operate, it was expected, to hold back a definite percentage of flood discharge—enough to keep the floods below the dams within safe limits. They would thus act automatically, just as forests are supposed to do. This was all right so far as the individual tributaries were concerned, but it was found, when the possible effect upon tributary combination in the main stream was considered, that by holding back earlier portions of freshets and prolonging their run-off, they might actually swell the combination in the lower courses of the main stream.

Similar studies have frequently been made in all the principal countries of Europe, and in none of them, so far as the author is aware, has such a project on a large scale ever been undertaken or even favorably considered.

Coming now to the Ohio River, the immense importance of that stream as a factor in the floods of the Mississippi makes the regulation of its flow a matter of greater moment than that of any other stream. The project of controlling the run-off of its watershed by means of reservoirs was urged very forcibly more than sixty years ago by Col. Charles Ellet. The subject has often been considered since, both in private and official investigations. The conclusion has invariably been that, great as the benefits of such a system would be if in existence, the cost of bringing it into existence would be out of all proportion to such benefits.

^a Report Commissioner of Public Works, State of California, for 1905.

^b Proceedings American Society Civil Engineers, May, 1908, p. 464.

^c Senate Document 160, Fifty-eighth Congress, second session, pp. 14-17.

The scheme has recently been revived in a more attractive form, with data not hitherto available, and at a time when a period of heavy floods and much loss therefrom has turned public attention strongly upon the subject. Moreover, it comes supported by a comparatively new element in its favor—the vast expansion of water-power development made possible by the electric transmission of energy. The new presentation of the project is by M. O. Leighton, Assoc. M. Am. Soc. C. E., Chief Hydrographer, United States Geological Survey, and is understood to bear the approval of both the Interior and Agricultural Departments.^a Mr. Leighton does not claim that his presentation is at all final or complete, but is rather a "statement of possibilities" which he believes are sufficiently promising to justify the Government in giving the scheme thorough investigation before further extensive steps are taken on present lines in the matter of flood control and channel improvement in the main rivers of the basin. Although an estimate of cost is submitted and certain conclusions are based thereon, it is stated that the data are too meager to give much confidence therein. Subject to these qualifications, the system, as set forth in Mr. Leighton's paper, embraces reservoirs on nearly all the tributaries of the Ohio; the total cost is estimated at \$125,000,000; the income from resulting water power at \$20 per horsepower, and a certain computed lowering of flood heights on the Ohio and Mississippi rivers, and a corresponding increase in low stages, are given. The full details of the scheme are set forth in quite elaborate form. So far as the present criticism is concerned, the practicability of finding the necessary sites will be accepted, and only the estimate of costs and revenues and the deductions as to benefits will be called into question.

In their effect upon floods, admitting that all the reservoirs proposed can be built, the result must fall short of the claims put forth. If built at all, they must be built, as will be shown later, primarily for power development. It will never be possible, until science can forecast the weather more perfectly than it is yet able to do, to regulate reservoirs for the maximum benefit of both purposes. This consideration is sometimes made light of, but nevertheless it is one of real importance. For industrial purposes the reservoirs should be full before the rainy season ends; for flood protection they should be so far empty that they may be able to hold back any flood-producing storm that is likely to come. While, doubtless, in a majority of years a middle course could be pursued that would not involve much risk on the flood side of the question nor much loss on the power side, yet there would surely come exceptional seasons—the seasons of flood-producing rains or the seasons of great drought—when the reservoirs would be caught too full on the one hand or too empty on the other. Their full calculated capacity would not then be available for either purpose, and it is difficult to conclude that this would not happen frequently. In particular, if the reservoirs are really operated to prevent floods, it must often happen that dry weather will find them only partially filled, and that their full capacity will not be available either for power or navigation. This would not apply, of course, to a reservoir great enough to store all the run-off from its watershed in the greatest known flood, unless considerable storage were left over from previous years—as is often done in the upper Mississippi reservoirs. Mr. Leighton's estimates are based upon the mean discharge of the streams, which is, of course, greatly exceeded, possibly doubled, in very wet years. In any case it would seem to be necessary to hold ample capacity in the reservoirs as late as the end of March each year to provide for possible emergencies; but if this is done there will be many years when the reservoirs will not fill.

An important consideration in the use of the reservoirs for flood control is that of a proper combination of their outflow. To anyone who will try to figure out how this can be accomplished over a watershed of such vast extent, with storms arriving at different times in the various portions, with no way of telling when, where, or with what intensity they will arrive, with the varying distances of the different reservoirs from those points where flood control is particularly important, the problem seems almost impossible—that is, impossible to realize the full effect based upon the aggregate capacity of the system. It is understood that Mr. Leighton has endeavored to do this, but it would be interesting to see the application to some of the great floods that might be designated.

^a The author has seen the description of the proposed system only as published in Engineering News, May 7, 1908. He has had some correspondence with Mr. Leighton, and is under great obligation to him for a complete set of topographic sheets showing the various reservoir sites.

For example, in the flood of 1907, which reached its maximum at Cincinnati and Pittsburg about the same time, no amount of holding back of the storm water on the upper Ohio at that time would have helped the situation at Cincinnati at all.

Another important consideration in the effect of these reservoirs, as they would have to be operated to prevent floods, is the great change that takes place in a flood wave as it propagates itself down stream. The author is unable to tell from Mr. Leighton's paper to what extent he has considered it. The paper itself seems to indicate that the discharge held back by a particular reservoir produces a corresponding volumetric effect (not gauge effect, of course) at all points below, after making a due allowance of time for the transmission of the wave. This would be an erroneous conclusion. For example, a wave that might rise at Pittsburg from 100,000 cubic feet per second to 150,000 a day later and to 200,000 the next day, and then fall at a corresponding rate, would not at any point below produce a maximum increase of 100,000 second-feet; and the farther away the point considered the less would be the increase. At Cairo, nearly 1,000 miles below, the same wave would take a much longer time in passing, probably not less than a week, and the maximum increase would probably not be more than 25,000 second-feet. This is merely a general illustration, for exact data on the subject are not available. The problem is of such complexity that nothing but the results of long experience could establish a rule as to what might be expected in any given case; but it can be stated with certainty that the diminution of discharge at any considerable distance below the reservoirs for a given time would never be as great as the amount held back by the reservoirs in the same length of time, and that the quicker and the higher the flood the smaller the relative effect at all points below. It is only when such wave elimination merges into a constant quantity, continuing for a considerable time, that the full effect of a reservoir would be experienced at any point below. This, in fact, is what would actually happen in the contrary case of the low-water season when the reservoir discharge is kept up for a long time.

Still another feature in the high-water effect of such reservoirs is the demand for water for power at all times. If there should ever result any really general use for all this water, as is predicted, then the consumption for power would make a considerable river in itself. Now, this much can not be shut off in any case. Street cars and shops must run and houses must be lighted, whether the flood is ruining the lowlands or not. An example of this occurred in 1905 on the upper Mississippi, where the outflow from the upper dams was cut down to a minimum to reduce the flood in the valley at Aitkin, which was then being overflowed by the river. The mill at Grand Rapids, just below the reservoirs, made a strenuous protest, and even threatened legal proceedings to compel the release of the full normal flow of the river.

Considering all the foregoing features of the operation of the proposed system, even if every reservoir were built with the full estimated capacity, it would be extremely fortunate if 75 per cent of the predicted results, either in flood protection or in aid of navigation, could be realized.

It is in the matter of cost, however, that the weak point of Mr. Leighton's system appears. Judged by any reasonable standard, his estimates are hopelessly wide of the mark. The method itself of getting at a basis of cost is inadmissible. For example, in determining a unit of cost for that class of reservoirs which embrace the greater portion of the total storage, the figures for nine reservoirs are taken, counting as one the whole upper Mississippi system. Only the Mississippi system has been built; two others are under construction and six are merely projected. In accordance with almost universal experience, and especially in view of the great advance in prices of all kinds since these estimates were prepared, it must be expected that these works, if ever built, will cost from 25 to 50 per cent more than the estimates. Three of the projected dams are of the relatively cheap rock-fill construction, which would be inapplicable to most of the Ohio dams from considerations of safety.

The controlling element, however, in the unit estimate is the Mississippi system, whose capacity is nearly one-third of the whole group considered and whose unit cost is only about one-seventh of the average cost of the others. The use of the Mississippi reservoirs in any way as a basis of estimate for the Ohio system is wholly inadmissible, because of the dissimilarity of sites. The Ohio sites, with one exception, are dry sites—totally different from the lakes of Minnesota. Even the latter reservoirs could not now be built for three times what they have actually cost the Government. The flowage lands embraced about 80,000 acres, which were nearly all reserved while yet belonging

to the Government. A few recent purchases of additional lands found necessary, and the experience now being met in acquiring the flowage rights for a reservoir at Gull Lake, show that if these lands were to be bought to-day they would cost from \$10 to \$25 per acre. The right of way alone would now cost twice as much as the dams.

Compare any one of these structures—Leech Lake, for example—with a representative masonry dam like the Cheesman dam on the South Fork of the South Platte River above Denver, Colo. The author is familiar with both sites and once submitted a plan and estimate for a structure on the Cheesman site almost exactly like the one built. Lake Cheesman is a more favorable site than most of those on the Ohio system, for, although its capacity is not as great as some, the dam site is exceptionally advantageous, one of the most perfect in nature—a very narrow gorge in solid granite, with a natural spillway already provided. In several of the Ohio sites entire towns will have to be removed, important railroads will have to be relocated, a few mineral properties will be destroyed, and, in nearly all, road systems will be seriously disarranged. None of these conditions were encountered to anything like the same extent in the Cheesman site. Undoubtedly its unit cost, which is estimated at about \$250 per 1,000,000 cubic feet, was as low as can be possibly realized on the Ohio system as a whole. Compare this with less than \$5 for Leech Lake or \$8 for the whole Mississippi system.

A recent example of projected storage is that presented by the late George Rafter, M. Am. Soc. C. E., for the Genesee River near Portage, N. Y. Owing to the moderate height of dam (apparently less than 150 feet) and the large capacity of reservoir (15,000,000,000 cubic feet), this is believed to compare favorably as to unit cost with the Ohio system. The estimate was \$216 per 1,000,000 cubic feet. If it were to be built under the present conditions of the market, it would doubtless cost \$250. It is understood that later investigations have shown that Mr. Rafter's estimate is only one-half large enough.

In 1895 the author made an extensive examination of storage possibilities in Ohio, near the divide between Lake Erie and the Ohio River, for the purpose of providing a water supply for certain projected canals. He prepared estimates for two sites on the head waters of the Cuyahoga, for one site at the head of the Scioto, and for one at the head of the Great Miami. The estimates were based upon actual surveys and are given in detail in the report upon the subject.^a The type of construction was not expensive. The total capacity was 11,000,000,000 cubic feet and the unit cost \$300. To-day it would be at least \$350.

Most of the proposed sites for the Ohio reservoirs are not advantageous sites. The topography of the country is unfavorable. The sites are not compact basins, like those occupied by lakes or ponds or mountain meadows, but are, for the most part, trunk valleys with numerous tributaries, nearly all of them quite narrow. They may be roughly compared to the form of the hand with the fingers outspread, the dam occupying the position of the wrist. The ends of the fingers are frequently many miles from each other and from the dam. Numerous villages occupy the valleys. The road systems of the local communities traverse them. The disadvantage that will result to public travel by forcing it out of these natural routes over the hills and around the ends of the fingers will be very great. The lands lying between the fingers, in some instances, will be so far cut off from convenient access that their value will be much impaired, and damages will have to be paid on that account. In several instances the necessary changes in railroad alignment in the hilly country will be extremely costly, if not impracticable. A great many cemeteries will have to be removed, which means not only the cost of removal, but extensive purchase of lands outside. Such drawbacks are, of course, encountered in all similar work, but they are excessive in these sites. They are mentioned solely from their relation to the question of cost. No one can examine the maps of these sites and not be convinced that the cost of right of way and damages alone will considerably exceed Mr. Leighton's estimate of the entire cost of the system.

An element affecting cost is that of safety. Owing to the situation of many of these proposed reservoirs the results of failure of the dams would be so appalling that no chances can be taken. The structures can be made safe, of course (except against earthquakes), but it will cost money. Nothing short of the highest type of construction—masonry for all the larger dams—can be considered. Mr. Leighton has cited certain dams upon the integrity of which great

^a House Document 278, Fifty-fourth Congress, first session, pp. 78, 83, 86.

interests depend as evidence of the confidence of engineers in these structures, but if he will apply their costs, particularly those of important structures in Europe, to his proposed system the money value of safety will mount up to a prodigious figure.^a

A feature of this question of safety often overlooked is the depreciation of the market value of property, due to its location below a dam, where failure of the dam would mean a disaster of great magnitude. However safe the structure may be many people would not purchase property below it, and its market value would be correspondingly diminished. While such loss can hardly be made a subject for damages, it is a real loss to the owners.

These reservoirs being built for flood protection, the sluices must be very large, so that at times they can be discharged practically as fast as the water runs in. This will be necessary during periods of prolonged precipitation in order to keep the reservoirs from filling too full before the danger is past. This detail of construction will add largely to the cost.

Taking everything into consideration on the most liberal basis, it is evident that this system can not be built for less than \$250 per 1,000,000 cubic feet. The probable increase in the value of property to be condemned before the system could be built and the present scale of prices of labor and material make this figure a minimum. This would swell the cost of the whole system to over four times Mr. Leighton's estimate, or over half a billion dollars.^b

This is not all, however. It appears that the complete development of the reservoir system as proposed will take from industrial use probably 1,500,000 acres of land, including the lands actually overflowed, the margins subject to damages, and sites for the dams and various structures appurtenant thereto. These lands will be in large part, by the very fact that they lie in valleys suitable for storage grounds, the best lands in the localities. Sooner or later they are bound to come into agricultural use, and with proper cultivation their annual net-revenue value will be at least \$5 per acre. If utilized for forest culture they ought to yield 500 feet board measure of lumber and 1 cord of wood annually per acre. The value of the land for this purpose ought to be as great as the figures just given. It thus appears that the occupancy of these lands for reservoir purposes will take from the community an annual product of at least \$7,500,000 worth, and probably more.

The reservoirs will store about 2,150,000,000,000 cubic feet of water. Assume that this can all be utilized for water power, with the average head of 200 feet, giving theoretically about 1,600,000 horsepower per year, or 1,280,000 horsepower at 80 per cent efficiency. At \$5 per horsepower (the basis for this figure will presently be considered), the revenue from water power will be \$6,400,000, which falls short of the loss resulting from withholding the sites from productive use.^c

^a The recent failure of the Hauser Lake Dam, on the Missouri River, near Helena, Mont., is a good illustration of how the unexpected may happen. Here was a dam built of steel and concrete, two materials whose properties are thoroughly understood. The case was one which "ordinary engineering" might be expected to handle successfully. The public had reason to feel confidence in the structure. Yet "it fell, and great was the fall thereof," not only in the total wreckage of the dam, but in the losses caused along the valley below.

The accident affords also another illustration of the omnivorous claims put forward in these days in the supposed interests of forestry. The disaster was promptly cited as an example of the havoc wrought by floods in a country without forests. The normal flood discharge of the Missouri at this point is 20,000 cubic feet per second; for 1907 it was 26,000 cubic feet; the maximum on record is about 50,000 cubic feet. At the time of the accident the discharge was about 7,000 cubic feet.

^b Recent examinations of certain sites, embracing nearly 70 per cent of the proposed Monongahela storage, indicate that the whole Ohio system will cost at least a billion dollars, and possibly a billion and a half.

^c The sanitary feature has not been considered, although it is one of some importance. The laying bare of large areas of reservoir bottoms in the heated portion of the year is objectionable, but it is not a matter affecting the element of cost. Neither is much stress here laid upon the danger to the reservoirs from silting up. This is not a region of heavy silt movement. In most of the reservoirs the process will be very slow, and we may safely leave to distant generations the task of dealing with this problem whenever it reaches an acute stage.

Viewed in the light of the foregoing exposition, the weakness of the reservoir scheme as a measure of flood control or for improving navigation is at once apparent. The question is, Will the ends justify the means? If the ends sought could be attained in no other way possibly they might; but they can be, and for a small fraction of the reservoir cost. Consider the estimate already given of \$500,000,000. Take \$40,000,000 and reinforce the entire levee system of the Mississippi. That will make it impregnable—as safe as any of the proposed reservoir dams. Take \$60,000,000 and revet the banks of the Mississippi wherever necessary from Cairo to the Gulf.^a The reservoir project does not touch this important matter at all. Devote whatever sum is necessary to the protection of the bottom lands of the Ohio basin. Give Cincinnati and Pittsburgh each \$10,000,000 to assist in local changes necessary for complete flood protection. Devote a sum to navigation such as our engineers have never dared dream of, and the Government will still save more than Mr. Leighton's estimate of the whole cost of the reservoir system. The more closely this reservoir proposition is scrutinized as a scheme for flood prevention the more impracticable it appears. It is only a trade-off at best. It is giving up to perpetual overflow valuable lands to save others from occasional and even rare overflow for short periods. Now if at less cost these low lands can be better protected by other means, thus leaving both the valley lands and reservoir sites open to productive use, how much better it will be.

If the author were to venture a criticism on Mr. Leighton's attitude in this matter, it would be that he has not fully appreciated his responsibility in bringing forward again this old proposition without fuller consideration of its organic defects. This is well illustrated in the opening paragraph of his paper, in which he says:

"This report will be confined to a statement of possibilities. There will be no attempt to prescribe methods for treatment of each local modifying condition that will be encountered in the prosecution of the plan here proposed. Such features are merely collateral, and their proper disposition is a matter of ordinary engineering."

This is a complete reversal of his obligation in the matter. The "possibilities" of reservoir control have long been recognized. The logic of the plan is well understood. It has always appealed to the popular mind. In particular, reservoir control of the Ohio floods has been advocated for more than sixty years, and its possibilities have often been investigated. The plan has been uniformly rejected on one ground, viz., that as a scheme for flood control and navigation improvement its benefits would not justify its cost. It is, therefore, incumbent upon whoever revives the scheme to come well fortified upon this particular feature. He must give some study to the treatment of "local modifying conditions." It makes a difference whether he can go to a great natural lake like Winnibigoshish and store 40,000,000,000 cubic feet of water for a mere trifle, or whether he must evict whole villages, disturb railroads and highways, absorb valuable lands, and possibly subject communities to serious risk. These are the questions upon which the success or failure of the scheme depends. Yet Mr. Leighton brushes them aside, as it were, with a wave of the hand, as "merely collateral" features, matters of "ordinary engineering" only. Here is the weak point of his project. Weighed in the balance of practical accomplishment, either for flood control or navigation, it will be found utterly wanting, and the development of the system, as has always been held, will have to be based primarily and mainly on its value for industrial use. For the same reasons that the development of a great reservoir system in the far West is justified by its industrial value—its use for irrigation—so a reservoir system for the Ohio, or any other rivers, except in a few unusual cases, must depend primarily upon its industrial value—the development of power.

In pursuing his criticism further, the author would not be understood to be "knocking," as current slang goes, the feature of the reservoir system just mentioned, because, in his judgment, there is no one thing in the present movement for the conservation of our natural resources that is more important than storing the flood waters of our streams for power development. It stands in the same category with the preservation and extension of our forests. It stands on even a surer basis, for man, either willfully or through neglect, can destroy the forests, but he can never diminish in the smallest degree the power of running water. It is a great solar engine, perennial and perpetual in its action.

^a Report Mississippi River Commission, 1896, p. 3457.

It requires no aid from man in its production. All he has to do is to utilize it. Providentially, electricity has unfolded its power to transmit this energy over great distances, and has thus made practicable a development which would otherwise have been impracticable. In time water power will replace coal and oil and will become the one great source of power, unless discoveries are made which are not now foreseen. The author thoroughly believes in developing this power through public agencies and preserving it from private ownership and control. His present criticism is directed not at all at the principle involved, but at the extravagant expectations now being fostered as to the possible revenue which the Government may derive from such development.

The quantity of power estimated in the publications of the Geological Survey and the Agricultural Department are based upon an assumption that most engineers will question, viz., that 90 per cent of the fall of our rivers can be utilized in effective head upon water wheels. This is too great a figure. The most thoroughly developed river in the United States, namely, the Merrimac, in New Hampshire and Massachusetts, develops only 70 per cent of the total head. Taking all the streams into consideration, it seems hardly possible that more than 50 per cent of the fall can be utilized. When the fall of a river is uniform, even if quite steep, the cost of long canals or high dams necessary to concentrate it at one point often prohibits development altogether. From altitudes of 3,000 feet the Missouri and Yellowstone, for example, descend to the sea with a total energy of possibly 5,000,000 horsepower, yet comparatively little of this can be developed advantageously. It is only in those places where nature has helped out by concentrating the fall at cataracts or rapids that water-power development is commercially profitable. At low dams, such as are ordinarily built at lock sites, the head is often nearly all obliterated during high water. How far storage may affect these drawbacks can not be said, but it should of course help a great deal. The official estimates of flow for non-regulated streams are based on two weeks' average lowest flow. This may probably be extended materially with reservoir aid or supplementary steam power. Possibly the total estimated horsepower may ultimately be realized.^a

When it comes to the royalty which the Government may receive for these water powers, if developed by private interests, the price of \$20 per horsepower, adopted by the Geological Survey and the Agricultural Department, is wholly out of the question under present conditions. Possibly the author does not understand what the figure is intended to embrace. From Mr. Leighton's articles the inference has been drawn that wherever the work of the Government renders power available which was not available before, either by building dams, as at lock sites, and thus creating a head, or by storing water which might supply powers below with more than they would have without, the value of the power thus rendered available should return to the Government \$20 per horsepower per annum—an "exceedingly low price," as Mr. Leighton puts it.^b

It is not understood that the Government is to build the power plants, but that this is to be done by the interests availing themselves of the privilege. Estimates of undeveloped water powers on many streams of the Atlantic slope by the Geological Survey leave one to infer that these powers are considered worth at least \$20 per horsepower to the Government even without dams or reservoir aid. While the statements are not clear as to what is actually meant, the various references to resources to be derived by the Government from these powers lead to the above conclusion. It would be of advantage in considering questions involving these published estimates, if the basis for this \$20 price or royalty could be made more specific.

Under present conditions, or such as can be reasonably foreseen, no such royalty is possible except in extraordinarily favorable circumstances. Efforts

^a There has recently been invented a device called a "fall increaser," an adaptation of the Venturi meter, by Clemens Herschel. M. Am. Soc. C. E., which promises to utilize the extra flow of streams in time of flood water and low heads to increase and maintain the head upon the wheels. If this invention proves a success, as seems probable, it will be an immense gain to all water powers of low head subject to large fluctuation, as would doubtless be the case in very many of those under consideration.

^b On the Youghiogheny alone, where it is proposed to install a slack-water system comprising three locks and dams, at an expense of \$600,000, proper development of storage will insure the production of a minimum of 4,100 horsepower, the value of which, reckoned on the exceedingly low price of \$20 per horsepower year, would produce a total income of \$82,000.

which have been made to derive a satisfactory revenue from existing powers do not justify any such prospect. The many and various practical difficulties in exploiting these powers are rarely appreciated by those who have not encountered them in actual experience. The cost of water-power development is restricted to narrow limits, if it is to compete with coal. An engineer of high standing, whose life work has been connected with water-power development, says:

"I am advised that, with good coal at \$2 per ton in this territory, the cost of fuel per horsepower per annum (300 days of 24 hours each) is less than \$8 for producer gas engines and for steam power about \$12.50 in large size equipments. In many localities coal will cost even less than \$2 per ton, allowing thus a still wider margin. If we now consider the usual and unavoidable handicaps and incumbrances to all water-power installations, such as floods, low water, ice flow, back water, etc., we have conditions which will make it a serious study for any power consumer to determine if the balance is not considerably against water power in that particular territory, at this time, from a purely commercial standpoint. At any rate it must be obvious that no such rate as \$20 per annum per horsepower can be paid to the Government by any power user for the right to draw the water only, and besides this, stand the expense of installing and operating the water plant."

Another hydraulic engineer of national reputation says:

"I think that as a general proposition the suggestion that all water powers to which the Government consents should pay royalties, and especially where the parties own their riparian rights, would tend to defeat the development of most water powers and would certainly very much curtail the number of water-power developments. I am impressed with these conclusions because of the present difficulties in financing good water-power propositions."

In Power, May 19, 1908, is an article by Henry Docker Jackson, in which a critical comparison is made between steam and water power. In this article occur the following tabulated estimates of cost of installation and of annual operation, based upon a (theoretical) installation of 1,000 horsepower. The costs are averages of a number of different plants:

PLANT COST.

Plant.	Steam.	Water.
Building and works	\$10,000	\$77,000
Engines, boiler, etc	48,000
Turbines and generators	15,000	17,000
Transmission lines, etc., 20 miles	40,000
	73,000	134,000

FIXED CHARGES.

Interest	\$3,650	\$6,700
Fuel, \$2.50 per ton	6,160
Water	600
Operation	3,400	3,800
Oil, waste, etc	770	500
Maintenance	1,500	2,680
Depreciation	3,650	3,500
Taxes	1,460	2,680
Insurance	650
	21,840	19,860
Cost per indicated horsepower per year	21.84	19.86

COST PER HORSEPOWER YEAR.

	Steam, 88 per cent.	Water, 95 per cent.
100 per cent load factor	\$24.82	\$20.90
75 per cent load factor	39.92	32.00
50 per cent load factor	54.60	45.00

From the last part of these tables, it is very evident that a royalty of \$20 per horsepower would turn the scale wholly in favor of steam under all conditions of load. In fact, it is reasonably certain that \$5 per horsepower per annum would be an outside figure, and even this would often be prohibitory. The situation will not necessarily be improved by the growing demand for power, but rather by the diminishing supply and increased cost of fuel. So long as coal can be had for anything like present rates no very great charge can be realized from water power wherever fuel is readily available. Under present conditions \$120 per horsepower may be considered as an average limit for first cost of a water-power plant, if it is to compete with steam. A charge of \$20 per horsepower per annum would be equivalent to doubling this first cost.^a

A variable element in the cost of water-power development is the distance from plant to market, or the length of the transmission line. When this is very great, as in numerous plants in the mountain districts of the West, it makes a large addition to cost of installation and must correspondingly reduce the royalty that could be paid for the power itself.

An interesting example of what the Forestry Service has been able to do in this line with unimproved water powers is that of a recent permit for the development of a large power in the Cascade Mountains within the forest reserve. The beneficiary of the privilege is required to pay annually for "conservation" 10 cents per 1,000 kilowatt hours—equivalent to 65 cents per horsepower per year continuous running. The right is retained by the Government to increase this charge 25 per cent every five years for a period of forty years, after which the whole arrangement may be readjusted. The maximum charge at the end of the forty years will, therefore, not exceed \$4 per horsepower.

The only way in which a rental of \$20 per horsepower can be obtained with any degree of certainty, and that in only a small proportion of the localities for many years to come, is for the Government to build the plants. It is admitted that this suggestion will grate harshly on many ears because of its newness and its departure from the established ideas. But a little consideration will show it to be not only the best way for both private and public interests, but really the only practicable way. This may be illustrated by a concrete example:

The Government has just completed a survey and adopted a project for the construction of what is known as the Lake Washington Canal in the city of Seattle. It is a canal to connect Lakes Union and Washington with Puget Sound. The discharge from the tributary watershed which will flow through the canal averages about 1,500 cubic feet per second. The mean fall at the lock site is about 15 feet. The theoretical energy is about 2,500 horsepower, but owing to the tidal fluctuation and variations of flow with the seasons (which can not be wholly eliminated on account of the necessity of limiting fluctuations of level in the lakes to about 3 feet, and also to the requirements for canal power, lockage, and leakage), it was thought that about only 1,000 horsepower could be depended upon with certainty for outside use. As this power is located in the heart of a great city, it seemed as if it ought to be turned to good account in helping bear the cost of maintaining the canal. Efforts to obtain tentative propositions for developing this power were, however, wholly fruitless. The plan was then considered of having the Government build the plant and lease it to consumers of power. On this basis a tentative offer was obtained from a responsible consumer to take the plant, operate it, keep up all repairs and pay the Government \$18 per horsepower year. Probably by the time the canal is completed, a figure of \$25 can be obtained, and as more than 1,000 horsepower will probably be developed, it is likely that the Government will receive upward of \$30,000 per year for this power—enough to pay the entire cost of operating the canal. The extra cost to the project of adopting the power-plant feature is \$220,000, so that the revenue will be nearly 14 per cent upon the expenditure.

In recommending this plan to the department, it was pointed out that the true advantage of the Government, even apart from the revenue expected, favored its adoption. It simplified the whole relation between the Government

^a Mr. Leighton cites the falls of the Ohio as an example of an opportunity to develop 110,000 horsepower by aid of his proposed reservoir regulation. This, he states, at \$20 per horsepower, is 3 per cent interest on \$73,000,000. To anyone familiar with the physical conditions involved in the development of this power it will appear extremely doubtful if any company could guarantee to deliver continuously this amount of power, even with the full aid of reservoir regulation, and pay any royalty whatever.

and the consumer. If private interests were to build the plant, they would acquire vested rights which would always stand in the way of future control and lead to complications if it should become necessary to terminate the arrangement. With the plant in the possession of the Government and the users standing simply in the relation of lessees for a limited period, without great initial expense on their part, and with freedom on the part of the Government to control the arrangement without the complication of private ownership, the whole plan would stand on a simple, practical, business basis. This view prevailed with the department and is now before Congress for adoption, being possibly a departure in this line.

The principle involved in this case should be given general application. In addition to avoiding complications with private ownership, there are other important considerations. When a power is developed or a reservoir built, it should be so planned from the start as to bring out its full possibilities. A private company can rarely do this. Generally its scheme does not require it, nor its resources permit; but a site once occupied by an inferior work may be perpetually barred from complete development. Moreover, in any such work, the Government can derive a greater benefit than any private individual or association. A private company must build for the immediate future; it can not wait long for dividends and it can generally realize only on such application of the power as is possible in the immediate vicinity. The Government, on the other hand, derives all the benefits which come from the stored water anywhere on its course from the reservoir to sea. These benefits arise from all the powers through which the water flows; from the improvement of navigation and the prevention of floods and from every other use to which the water can be put. Furthermore, the Government is building for all time, while the individual builds only for the present and near future. The case is similar to that of landlord and tenant. A tenant can not afford to make improvements on the farm because it is not his and he may remain on it only a short time. The most he can do is to get out of the farm what he can in its actual condition. The owner, on the other hand, can put in improvements which yield him no immediate return because he holds the property long enough to realize upon them. So it is with the Government; it can wait for realization upon its improvements much longer than a private company. In forestry, for example, no individual can afford to wait from three to ten generations for a crop. Only the Government or a great railroad corporation can do this. Likewise, in building great reservoirs, no private company can build for the distant future. It is only the landlord that can make such far-reaching improvements upon his estate.

Wherever, therefore, there arises any real demand for power development at the site of any government work, as a lock and dam, the judicious course would seem to be for the Government to prepare a comprehensive plan for development capable of being carried out progressively as the market for power may justify. Let it then build the plant as fast as needed and lease it to private agencies under suitable restrictions. Likewise, when the building of a reservoir promises to be of obvious utility, and the conditions are such as to make it properly a subject of government adoption, let the Government build it, utilizing the water in its own plants below and collecting a revenue from private plants that may use it. Whenever at the time of construction there is a direct return in sight of 2 or 3 per cent, it should be considered justifiable from a Government point of view. The certain enhancement in the future value of such utilities and the incidental advantages in flood protection and navigation make this a conservative proposition.

That difficulties will be encountered in deriving the full return from its work to which the Government would be entitled can not be denied. This would be the case, particularly wherever it is a question of compelling existing power plants to pay for the extra water they might receive through government storage. This question came up before the Mississippi Reservoir Board in regard to the powers at St. Anthony's Falls which derive such benefit from the reservoirs. The board remarked as follows on the subject:

"It may be urged that if the incidental benefits of the reservoirs to the water-power interests are so great, these interests should be required to contribute something to the maintenance of the system. There would doubtless be a willingness to do this if a satisfactory method could be found. But there is no practicable method of enforcing any charge upon the use of this water. Where water is taken in a separate channel from above a dam or lock and conducted to a mill, it is a simple thing to measure it and to cut it off if it is not paid for.

But when it must be let into a natural stream, where it mingle's with the run-off from below, it is impossible to determine what proportion of stored water the mill may be using or to enforce its nonuse if not paid for. But, if such an arrangement is not practicable, that fact does not constitute an argument against the reservoir system. So long as the reservoirs are performing the service for which they were created, every additional benefit derived from them is only an additional argument in their favor."

These disadvantages will adjust themselves in time.

Such, in the opinion of the author, must be the basis of any great reservoir system in our country—industrial use. Even in the uniquely favorable conditions at the headwaters of the Mississippi, no one can doubt that the real purpose being served is that of mill power, whatever the theory upon which the reservoirs were built. The great system of the far West is being built for irrigation, power, and domestic supply. So on the Ohio and other eastern streams, the system must rest upon an industrial basis and expand only as industrial demands justify. The innovation involved in building reservoirs with public funds for these uses is admitted; but it is no greater than it was ten years ago to build them for irrigation. When the author was investigating that subject in 1896-97, he found a widespread opposition throughout the arid regions against government control of irrigation works in any way, and in his report he went no further than to advise the building of reservoirs for giving the people more water, leaving its distribution exactly as it was before. Yet in the short space of ten years public sentiment has completely changed, and to-day no one questions the wisdom of the broader plan upon which these works are being carried out. So it will surely be in regard to reservoirs in all other parts of the country. The principle is the same. It may be accepted that only the general Government can do this work in the comprehensive way in which it ought to be done, because only the Government can reap all the benefits; only the Government can wait the long periods necessary for full returns; and only the Government has the necessary resources to make expenditures on the required scale. These points will not be enlarged upon, and the many and cogent reasons why this is so will not be given. The trend of public thought is all in that direction. The old idea that the Government can not execute great works or small as cheaply, efficiently, and expeditiously as private agencies is fast being dispelled, and the vast benefits which the people derive from public control of important enterprises are coming into fuller recognition all the time.

The foregoing remarks should not be construed as in any way rejecting the idea of local help by States, counties, cities, or even private agencies. It often happens that public works have a special local importance in addition to their public value. It is just and proper in such cases that local aid be given. This principle is now fully incorporated in river and harbor legislation. For example, the Lake Washington Canal, which will be of very great importance to the city of Seattle, is a joint enterprise between the Government and the city, the latter paying fully one-third of the cost. The cooperation between the United States Geological Survey and the several States in preparing a contour map of the country is an example on a large scale. The principle ought to find an extensive application in the establishment of national forests throughout the country.

CONCLUSION.

This paper will be closed with some reference to the relation of navigation to other uses of our streams and to certain legal obstacles that stand in the way of comprehensive measures. That the improvement of our inland waterways should be organized upon a more rational system than it has ever been; that the reciprocal relation between navigation, water power, etc., should be given practical recognition; above all, that the prosecution of these works should be placed upon the same sure basis as is the construction of the Panama Canal, with positive assurance that, when once commenced, funds will be forthcoming for their prompt completion, would seem to admit of no doubt. How far navigation should be correlated in improvement work, with other uses of the streams is an open question. Water power and navigation are in many cases so closely related that they will have to be considered together. In regard to soil wash, no such intimate relation exists. To whatever extent soil erosion now exceeds that of former times it relates almost exclusively to cultivation and has no appreciable influence upon the channels. Its control is of far greater importance to agriculture than it is to navigation. This is also true of irrigation, which, so far as it affects navigation at all, affects it in

juriously. If the development of irrigation is ever carried to the length that we hope it may be, it will cause a heavy drain upon the low-water flow of the Missouri, Sacramento, San Joaquin, and the Columbia rivers (not important as to this stream), the only navigable waterways of consequence that are affected by it. Except for this fact of drawing water from the stream, irrigation has no relation to navigation.

Forestry, irrigation, and prevention of soil wash are all related to the conservation of the vegetable resources of the country. They are kindred purposes and should naturally fall under the same administrative control. Navigation is a function of transportation, which is a very different subject. Water power is becoming more and more closely related to it, and these two subjects naturally go together. It must not be expected that the character of works for river regulation can be materially changed by means of reservoirs, forests, or soil-wash prevention. Levees and bank protection, locks and dams, dikes and dredging will continue to be standard methods of river improvement in the future as in the past. The accumulated experience of centuries in all civilized countries can not be set aside in a moment. In particular, flood protection is not likely ever to find any complete substitute for levees. They have been used extensively the world over throughout recorded history. People who think only of the Mississippi and the Po, when levees are mentioned, little understand to what an extent "diking" is resorted to wherever rich bottom lands have to be guarded against floods or tides. Some of the finest agricultural lands in the world are behind levees where almost perfect security is felt. No class of river control is in more extensive use, none is better understood, and from none has the world, throughout its history, derived greater security and benefit.

Municipalities, like Pittsburg, Cincinnati, and Kansas City, must look in the main to their own efforts for protection against floods. In particular they must reject absolutely the delusive promises of forestry. These cities are trespassers upon grounds dedicated by Nature to a condition of overflow. They have occupied these grounds and placed themselves in the way of the floods deliberately and with their eyes open. They have gone farther than this, and in many instances have encroached upon the channels and have thus made the floods worse than they used to be. It is not for them now to look for outside deliverance, but they themselves should grapple courageously with the problem. In most cases these problems admit, if not of complete solution, at least of a very large measure of relief. The maxim that Providence helps them who help themselves may also apply to the Government. Cooperation in connection with its regular work, either in channel improvement or in the building of reservoirs, would doubtless be given. The disposition which must be met and overcome is to let things go as they are, trusting blindly to chance to deal more kindly in the future. This supineness of spirit and the enervating reliance upon indefinite future relief through the agency of the Government must be replaced by self-reliance, and these great industrial centers must rise in their own might and free themselves from their bondage to these ever-recurring catastrophies. In Boston, Chicago, Galveston, San Francisco, and even in that lusty young giant of the Northwest, Seattle, are examples enough of what an aroused civic spirit can do in the direction of self-aid.^a

The part that reservoirs will play in the larger problems of channel improvement and flood control on the great rivers will be in the nature of an insurance. Every cubic foot of water taken from the crest of a flood and released when the rivers are lowest is *pro tanto* a benefit. If the great floods of the Mississippi can be cut down by so much as a foot through reservoir storage, it

^a The author is not closely familiar with the situation at Pittsburg and Cincinnati, but he is familiar with that at the two Kansas Citys where, in 1903, the greatest loss occurred that any American city ever sustained at the hands of a river flood. He speaks from the results of careful study on the ground when he states with the utmost positiveness that for approximately \$10,000,000, with such aid as might reasonably be expected from the Government on the Missouri River front, the flood problem of the Kaw and Missouri in that hive of industrial enterprise known as the West Bottoms can be solved absolutely; the too small area of these bottoms can be increased by upward of 200 acres; two-thirds of the bridges in the same area can be eliminated; that prodigious barrier to free movement—the Kaw River—can be practically removed or placed where it will not be in the way; and the general situation can be so improved that the resulting benefits, wholly apart from that of flood protection, would be well worth the cost.

will be an immense gain; and the same will be true if the low-water stages can be increased by two or three feet. Whether the much greater results expected by Mr. Leighton can ever be realized is a question which the future alone can determine.

A word, finally, concerning the legal obstacles in the way of a broad Government policy looking to the development of national forests and the storage of water on an extensive scale. The expansion of Government work into fields of obvious utility is often blocked by the structure of our Government through the bar of constitutional prohibition or at least lack of power. It is said that the purchase of lands for the rearing of forests for timber alone is unconstitutional, and that the same is true of the storage of water for any other purpose than navigation; and yet, forests for timber and reservoirs for power must always remain the real justification for public expenditure along these lines. To the average understanding the distinction between things constitutional and things unconstitutional is often hard to discern. The Government is now expending millions in storing water and conducting it upon land whereby the products of the soil may be obtained. It is applying this water to both public and private land, or to lands that were in private ownership when the projects began. Is there any real difference between providing the power to raise sugar beets, for instance, and that for manufacturing them into form for human consumption and transporting them to the consumer? Are not the last-mentioned purposes quite as necessary as the first?^a And again, is there any distinction in principle between improving a river so that boats can navigate it and improving it so that it may provide power that will transport produce by land as well as by water?

Again, the Government has accepted gifts of land like the Yosemite Valley and the Muir Redwood Grove, to be given over to the enjoyment of the people and involving perpetual expenditures for maintenance in the future. It has traded lands of its own for lands with which it has parted ownership. It reserves vast areas to-day which might be private lands to-morrow. What is the distinction of principle between doing all these things and buying outright lands that are needed for the same or similar purposes? They are distinctions without real differences. They concern the letter and not the spirit, and they can not stand whenever the interests of the public really demand their abrogation.

Still, it is probably a fact that federal authority to buy lands for forest culture alone and to create reservoirs for industrial use exclusively, would be considered by the courts as transcending the power of Congress under the Constitution, and it is this fact that forces those who believe in having the Government do these things to strain the truth by attempting to prove that they are necessary for navigation and for the prevention of floods. It enforces a policy of indirection instead of permitting these things to be done squarely for their real purpose and as a matter of right. In his address before the Judiciary Committee, in its hearing on the Appalachian bill, Mr. Pinchot stated that that proposition must stand or fall upon the theory that the forests regulate stream flow, and are therefore useful to navigation. Did he not refer to the particular point here under consideration—that on any other theory the measure would be unconstitutional? Surely he did not mean that the cause of forestry itself must stand or fall upon any such issue.

Does not this situation suggest the necessity for an important initial step which shall sweep away these artificial barriers and let these great questions stand or fall on their intrinsic merit? If the upbuilding of new forests, if the storing of our flood waters, are necessary measures for the welfare of the nation, the way should be cleared for their accomplishment. There may be differences of opinion about amending the Constitution in the interest of uniform divorce laws, popular election of Senators and the like, but, if we may judge from the universal agreement upon the particular subjects here considered, every State in the Union would ratify an amendment giving to Congress the power to legislate for the conservation and development of the natural resources of the country.

The author should possibly state, in justice to the official body of engineers to which he belongs, that the arguments presented in the foregoing paper are his individual opinions only. He is not acquainted with the views of any other officer upon the subjects treated, except as he has seen them expressed in official reports or in the public press.

^a It has even been hinted by high judicial authority that the reclamation act itself would not stand the test of constitutionality, if brought into court.

THE EQUALIZING INFLUENCE OF FORESTS ON THE FLOW OF STREAMS AND THEIR VALUE AS A MEANS OF IMPROVING NAVIGATION.

[Being mainly a rejoinder to the paper of Col. H. M. Chittenden, U. S. Army, entitled "Forests and reservoirs in their relation to stream flow, with particular reference to navigable rivers," presented before the American Society of Civil Engineers. Prepared at the request of His Excellency Curtis Guild, Jr., governor of the State of Massachusetts, by George F. Swain, LL. D., professor of civil engineering in the Massachusetts Institute of Technology.]

It is the opinion of probably the great majority of engineers conversant with the subject, that forests act as equalizers of the flow of streams by diminishing, in general, the frequency and violence of freshets, and increasing the low-water flow, and by preventing the erosion of the soil and the consequent silting up of water courses.

Based on these premises, it is believed to be of much importance to the interests of navigation as well as to other interests, that the United States Government should establish forest reserves in the Southern Appalachian and White Mountains, the object of such reserves being:

First. To aid in the protection of certain given watersheds.

Second. To enable the Government to give an object lesson to private owners in the vicinity as to what may be accomplished by proper forest management, and to cooperate directly with such private owners in encouraging them to use the best methods.

Third. To aid in preventing forest fires and the consequent deterioration of the soil and destruction of timber on both government and private lands.

Fourth. To aid in and encourage reforesting, and by this means and by proper management to augment and prolong the timber supply.

In September, 1908, a paper, the title of which has been quoted above, was published in the Proceedings of the American Society of Civil Engineers by Col. H. M. Chittenden, of the Corps of Engineers, U. S. Army, in which arguments were advanced which in a measure seem to controvert the generally accepted opinions. The present paper is a brief rejoinder to that article, prepared with special reference to its bearing upon the Appalachian and White Mountain Forest Reserve bill.

The paper of Colonel Chittenden is exceedingly well written, and upon first reading might seem to contain strong arguments against the regulative action of forests. Upon analyzing its statements, however, it will be perceived that Colonel Chittenden practically acknowledges most of the claims made for forests, that the paper contains many contradictory assertions and illogical deductions, and that his arguments are largely conjectural and unaccompanied by proof.

The paper states that the commonly accepted opinion is that forests have a beneficial influence on stream flow (1) "by storing the waters from rain and melting snow in the bed of humus that develops under forest cover * * * preventing their rapid rush to the streams and paying them out gradually afterwards, thus acting as true reservoirs in equalizing the run-off; (2) by retarding the snow melting in the spring and prolonging the run-off from that source; (3) by increasing precipitation; (4) by preventing erosion of the soil on steep slopes and thereby protecting water courses, canals, reservoirs, and similar works from accumulations of silt."

This will probably be admitted to be a fair statement of what the believers in the benefits of forests consider to be true, except that some do not consider that there is yet sufficient demonstration that they increase the rainfall, and also except that the water is not stored simply in the bed of humus, but also in the ground beneath.

With reference to the first of these points, the author states that it is "strictly true of average conditions." He says: "It is true, therefore, as popularly understood, that, in periods of ordinary rainfall, with sufficient intervals for the forest bed to dry out somewhat, forests do exert a regulative effect upon run-off. They modify freshets and torrents and prolong the run-off after storms have passed, and therefore realize in more or less perfection the commonly accepted theory."

He believes, however, that this beneficial effect is not exerted under extreme conditions, i. e., great floods and excessive low waters, and he states that these extreme conditions "determine the character and cost of river control."

Even if it be admitted that the presence of forests does not affect "extreme conditions," this is no argument against the value of forests, for it is

certainly not true that only extreme conditions affect the navigability of streams or "determine the character and cost of river control." Extreme conditions determine certain elements, such, for instance, as the height of levees. Colonel Chittenden certainly can not mean to state that ordinary, everyday floods do not carve away banks and cause shoaling of channels, rendering dredging necessary for navigation. A few high but not extreme floods may do much more damage than one extreme flood, and may necessitate more expenditure for dredging and other purposes. Extreme conditions are in the nature of freaks. They occur only at intervals of many years. It would seem to be more nearly correct to state that the interests of navigation are governed more by the usual conditions, and that it is possible for extreme conditions at rare intervals to interrupt traffic for a short time without causing much loss. It may as well be argued that it is not wise to attempt improvements on railroads because an earthquake or a tornado or an extreme flood in a river may destroy a portion of the track and interrupt traffic for a while. It matters little in the navigability of a stream if at intervals of twenty, thirty, or fifty years an extreme drought occurs for a few days or weeks, making the depth of the channel insufficient for the largest vessels.

If it be true, therefore, that extreme conditions do not govern the question, Colonel Chittenden has admitted all that the advocates of forests desire. Let us consider, however, the arguments with reference to such extreme conditions:

The argument with reference to extreme floods appears to be that floods are always the result of combinations from various tributaries; the highest flood from one stream coming at the same time as the highest flood from other streams, occurring after periods of long-continued and widespread precipitation. In such cases the forest bed becomes completely saturated, its storage capacity exhausted, and when this point is reached "the forest has no more power to restrain floods than the open country itself."

It is of course evident that the rainfall may be so great and long continued that the forest bed becomes saturated and that the water flows over the surface, but it does not seem incorrect to say that in this case the forest has no more power to restrain floods than the open country itself. The discharge will be hindered in the forest by the physical conditions and because the soil will not be washed away and the water will not be gathered into torrents flowing down through eroded channels. Moreover, it seems a strange argument to maintain that because the retentive power of the forest is not unlimited it is not therefore useful. Even if it be admitted, however, that under a torrential rainfall the water flows away from the forest without hindrance, it is under just such a condition that the forest is most valuable in preventing erosion, for the water is distributed over the forest floor and does not carry away with it the earth beneath. With reference to this point, however, Colonel Chittenden maintains that there is no more erosion from cut-over lands than from forested lands. There are certain reasons for believing that he is not correct. In the first place, the forest cover is always more or less disturbed or injured by the cutting, and after cutting is done it is more exposed to the sun and becomes dryer in summer and more liable to take fire. It is believed to be a fact that fire very frequently follows the lumberman and originates on cut-over land. This still further destroys the forest cover, and heavy rain falling on deforested ground is not broken in its fall by the leaves and branches of the trees. In many places, of course, a new growth springs up after the forest is cut, if it is not prevented by fire, and this new growth will in the course of time become a new forest and the old conditions will be restored, but in the meantime there is a deterioration of the soil covering and a greater liability to erosion, as well as a smaller power of retention and consequent more rapid discharge of the rain waters. In some parts of the White Mountains, tracts once cut clean and burned over do not grow up again.

Colonel Chittenden suggests that under extreme flood conditions, such as have been referred to, the presence of a forest may actually produce a worse condition than if the country were cleared, and asserts positively, but without proof, "that the forest does promote tributary combinations * * * and that it may therefore aggravate flood conditions." He continues, "that forests never diminish great floods, and they probably do increase them somewhat." As this statement is not proven, it can only be regarded as Colonel Chittenden's personal opinion. There is certainly no more reason for believing that forests promote the combination of floods from different tributaries than that they have

the opposite effect. It may be admitted, however, that it is possible to conceive of circumstances in which, under extreme conditions, the presence of a particular forest may increase a particular flood at a particular point. It is equally possible to imagine many more conditions under which the reverse would be true, and it is clear that if the forest has a restraining influence on the discharge of water from the surface, increasing the amount of percolation into the ground, to reach the surface later at lower levels by springs and seepage, it must, in the vast majority of cases, reduce the frequency and violence of floods.

It is true, as stated by Colonel Chittenden, that the records of high water in most streams do not show that the waters now rise, under extreme conditions, higher than extreme floods which have occurred in the past. The highest recorded flood on the Connecticut River occurred in 1854, long before the present rapid rate of cutting on its upper headwaters had begun. Similar facts are no doubt true of other streams. Exceptional conditions are always likely to occur, but, as mentioned above, it is not exceptional conditions which should govern in this question. To do so is like arguing against the benefit of food for the reason that a man's food may choke him, or against the benefits of the sun's heat for the reason that people occasionally get sunstruck.

Colonel Chittenden illustrates the action of a forest by considering an inclined-plane surface "practically impervious to water," with a layer of sand covering some small portion of it, and to which a spray of water is applied. This comparison, however, is not a correct one, for the forest cover does not rest upon an impervious surface. The forest and its cover prevent the earth beneath from being baked by the sun and compacted by the rain. It is kept in a porous condition, ready to absorb water which filters down to it through the forest cover. Any conclusions, therefore, drawn from Colonel Chittenden's simile must be inaccurate.

The author's summary of this part of the discussion is perhaps contained in the following sentence: "That the forest does promote tributary combinations there would seem to be no question, and that it may therefore aggravate flood conditions necessarily follows. It is not contended that this increase is ever very great, but it is contended that forests never diminish great floods and that they probably do increase them somewhat."

It would seem to be much nearer the truth to say that forests generally diminish floods, although it is conceivable that a forest may slightly increase a given flood at some points.

The author further states that "the forests are virtually automatic reservoirs, not subject to intelligent control, and act just as the system of reservoirs once proposed by the French Government for the control of the floods of the River Rhone would have acted if built. These reservoirs were to have open outlets, not capable of being closed, which were intended to restrain only a portion of the flow. A careful study of their operation in certain recorded floods showed that they would actually have produced conditions more dangerous than would have occurred without them."

The last sentence of this quotation is rather conjectural and its meaning not quite clear, but it will be surprising to most people to be told that a reservoir not subject to intelligent control does not regulate, and they will hardly accept the statement. Of course a lake is a more efficient regulator than a forest, because if its level is rising the discharge from its lower end is always less than the flow into its upper end, while in the case of the forest, when its storage is exceeded, its level can not rise, and it can simply hinder the discharge of later rainwater by physically obstructing its flow.

The general aspect of this part of the subject seems, after all, quite simple. The forest floor absorbs a large amount of water, prevents it from flowing off rapidly, and allows it to gradually percolate into the porous ground beneath. If the land were clear of vegetation, or if it were cultivated, and especially if the slopes were steep, the erosion would be greater and might sooner or later leave no soil upon the rocks to serve as a reservoir in future storms. The author's argument, therefore, leaves unassailed the beneficial effects of forests in regulating flow.

The fact must be emphasized that those who believe in the beneficial effect of forests upon flow do not urge the preservation of the forests on lands needed for agriculture. The beneficial effects of the forests on flat lands in modifying the violence of freshets and increasing the low-water flow is much less clear

than in the case of forests in steep mountain regions. It is the preservation of these last—forests upon land not suited to agriculture—that is believed to be especially important from every point of view.

The statement of Colonel Chittenden that the flood of 1908 in the Western States would have been much greater if the region had been forested, is a mere statement of his own opinion, entirely without proof, and undoubtedly incapable of proof; and further, if the gauge records given by him show that it is impossible to find evidence in them to support the current theory of forest influence, it may also be stated that there is nothing in them to support his own contention.

The question will, of course, have occurred to the reader of these remarks, Why it is not possible by long-continued observations of the height of floods on our rivers to settle this question absolutely? With reference to this some explanation is necessary. The flow of a stream is the resultant of a number of elements, chief among which are rainfall, its distribution throughout the year and over the area considered, the slope of the ground, the area of forest, cultivated land, etc., the number of lakes and reservoirs, the temperature, and other elements. The chief of all of these is undoubtedly the rainfall and its distribution. A great fall of rain, long continued, will probably cause a great flood whether there are forests or not, although, as before explained, there is abundant evidence for the contention that the action of the forest is to diminish the flood. Meteorological phenomena are admittedly variable and uncertain, and, of course, they are entirely incapable of control. The rainfall varies from year to year in long cycles, the extent of the variation being such that in the United States it has generally proved impossible to determine with certainty whether the rainfall over a given territory which has remained in essentially the same physical condition, is increasing or not. The rainfall at a given place may vary from 30 inches in one year to 50 or 60 inches in the following year, and its distribution is subject to similar variations. These variable elements therefore may mask the influence of forests or of reservoirs, but the important point is that these two are the only elements subject to man's control.

It is admittedly physically possible, by reforesting and by the construction of storage reservoirs, to make the flow of a given stream practically uniform throughout the year, although to do so would in most cases involve a prohibitive cost; and, moreover, it would be physically impossible to regulate a reservoir and allow the water to flow out of it in such a way as to produce this effect, because the future can not be foreseen. Observations of gauge readings on rivers, therefore, are inconclusive in themselves. Fortunately, however, we are not without valuable evidence on this point. Mr. M. O. Leighton, chief hydrographer of the United States Geological Survey, has, during the past summer, made an elaborate study of the floods of the Tennessee River, in which he has endeavored to eliminate the effect of the rainfall and its distribution by comparing the number of days of flood with the number of individual rainstorms of sufficient magnitude to produce floods. The record shows that during the last half of the period studied the number of days of flood was actually less than in the earlier part of the period, notwithstanding the deforestation which has recently taken place. The rainfall, however, has also been less in the latter period, and the results of Mr. Leighton's study are that the diminution of the rainfall has been much more than sufficient to account for the diminution of the floods, so that the actual result is that the floods have been increasing, the percentage of increase being 18.75 in the last seventeen years as compared with the seventeen years previous. This study is the best contribution to the subject which has come to the writer's knowledge, and it seems conclusive. The experience in France also furnishes valuable evidence in this matter.

In 1857 M. F. Valles, a French government engineer, published a work in which, and in some subsequent papers, he gave almost the identical arguments advanced by Colonel Chittenden, maintaining that forests diminished the rainfall, increased the floods, and diminished the supply of grain by withdrawing lands from cultivation. He also maintained that floods were beneficial by bringing silt from the mountain sides to the plains. His work, however, seems to have been entirely without influence, for immediately after its publication the French Government entered upon a policy of forest protection and reforestation, particularly in the mountain regions, which has been continued up to the present time. Up to January 1, 1900, the State had acquired over 400,000 acres, or 629 square miles, for the purpose of controlling torrents. Of this area 440 square miles are in the Alps, 145 square miles in the central plateau and

the Cevennes, and 44 square miles in the Pyrenees. The expenditure has been as follows:

For acquisition of land	\$5, 200, 000
For work of reforesting	4, 000, 000
For work of regulating	2, 600, 000
Miscellaneous	1, 600, 000
Total	13, 400, 000

and there is still to be expended under the plan contemplated about \$23,000,000 more.

Referring to this work one of the most recent writers on the subject (G. Huffel, *Economie Forestiere*, 1904) states: "The rôle of the forest as a regulator of the flow of streams may be considered as evident, and it is to-day universally admitted." Under the able direction of Prosper Demontzey, chief of the service of reforestation in France for 1882 until retired in 1893, and of his predecessors, much has been accomplished, and some formerly very destructive torrents have been reduced to inoffensive streams by reforestation and regulation, much more being expended for reforestation than for regulation, as above shown. Perhaps it will now be argued that the good results that have followed have been due entirely to the regulation and not to the reforestation, but that is not the view of the French engineers.

At first there was great opposition to the French governmental policy on the part of the inhabitants of the mountain districts, and in 1864 there were riots in some places. This opposition, however, has entirely subsided, the inhabitants now cooperate heartily with the Government, even petitioning to have it extend its work, and in some cases even giving portions of their lands on the mountain sides without compensation.

When it comes to the question of extreme droughts, Colonel Chittenden takes a curiously contradictory position to the one which he takes in considering the matter of floods. Regarding the latter, it will be remembered, he considers that the forests may cause a combination of the highest floods arising simultaneously from different tributaries; with reference to droughts, however, he assumes just the reverse, namely, that the extreme low water on different tributaries will not occur simultaneously. It seems clear that the extreme combination is as likely to occur in one case as in the other.

He admits "that, as a general rule, springs and little streams dry up more completely than when forests covered the country," but he argues that, since each spring is small, their drying up will have little effect upon the main stream, the flow of which will be kept up, if the region is deforested, by the rapid discharge, over the surface, of the water from summer showers, which will occur, first on one tributary and then on another, in such a way as to furnish to the main stream always a low-water flow greater than if the springs could all be kept up. If his argument be carried to the very common case where no rain falls upon a given drainage basin for weeks, or for a much longer time than it takes for a drop of water to flow from the extreme source to the mouth, it would seem to lead to the conclusion that there would be no flow at all in the stream. In other words, the author would have the mills at Lawrence and Lowell depend for their summer flow, not upon keeping up the "springs and little streams" so far as possible by increasing through the effect of forests the percolation into the ground, but would have these mills trust to luck that the summer showers would be so distributed over the different tributary basins that when one was low others would be high, and he maintains that in this way the low water would be greater than if all the little springs were kept up. This would, of course, require most intelligent planning on the part of Jupiter Pluvius, for it would not do to have these summer showers, which are supposed to flow rapidly from the surface, inaccurately timed or distributed over the basin. It does not seem necessary to pursue this suggestion further.

Even a large drainage area, say 10,000 square miles, may well have its main stream possess a length from extremest source to mouth, measured on the stream, of considerably less than 300 miles. If the average velocity of the stream is 1 mile an hour, which is low, it would take less than two weeks for a drop of water to pass from the extremest source to the mouth. Now, even in districts which have a summer rainfall, it frequently happens that even an area as large as that mentioned is without rain in any part of it for months at a time, under which condition, if the writer understands Colonel Chittenden's theory and his admission, even such a large stream would practically dry up.

It would seem to be much more reasonable to depend upon some means of keeping up the springs and small streams rather than upon the equal distribution of surface waters of the summer showers from deforested areas.

Moreover, it is not evident why, even in a small stream, a uniform flow is any less desirable than an intermittent flow. Of course, as is well known, the larger the stream the greater the low-water flow per square mile, other things being equal, for the very reason that the low-water flow on all tributaries will not occur at the same time, no doubt partly owing to local rains. A precisely similar remark applies to the flood discharge, which is less per square mile on large watersheds than on small ones, because the maximum discharge from different tributaries will not occur at the same time. Colonel Chittenden, therefore, seems here inconsistent. In discussing floods he considers an extreme condition in which the floods from various tributaries arrive simultaneously at a given point, and from this he argues that forests increase the violence of floods. In the case of extreme droughts, however, he considers the case, not where the low-water flow from various tributaries arrive simultaneously at a given point, but, on the contrary, where comparatively high water from one arrives at the same time as the low water from another.

With reference to the effect of forests upon snow melting, Colonel Chittenden states that "it can be demonstrated that the effect of forests upon the run-off from snow is inevitably to increase its intensity."

He argues that the snow does not drift at all in the forests, but that great drifts form on open ground; that the snow begins to melt over open ground earlier than in the forests, and that the drifts on open ground serve as reservoirs to feed the streams, lasting much longer than the snow in the forests; that the snow melting in the forests does not sink into the ground, but into the snow itself, which becomes saturated, until a warm rain carries off the whole mass of snow in a freshet. He says, referring to the snow in the forest: "The water from the first melting from the snow blanket does not sink into the ground, but into the snow itself. Snow is like a sponge; a panful will shrink to one-fourth of its volume or less before any free water appears."

This argument contains a number of errors and inconsistencies. In the first place, the snow does drift in the forest, although not to the same extent as in the open. Colonel Chittenden admits that the snow blanket lasts longer in the forests than in the open, except for the drifts. It is the present writer's experience, however, that the snow in the forests lasts considerably longer than even the drifts in the open, although this may not be true in the case of very high altitudes. The snow in the drifts on or near the summit of Mount Blanc, of course, lasts longer than the snow in the forests below, because the top is in a region of perpetual snow. Obviously this is not the condition to be considered in the present instance. But Colonel Chittenden ignores the fact that under the snow the ground in the forest is warmer than the ground in the open and that the snow blanket melts at the bottom rather than at the top. Frequently the ground in the forest does not freeze at all and therefore it is in a better condition to absorb the melted snow than the ground in the open. But even if the snow blanket in the woods absorbs, as he thinks, the water from its own melting under the sun's rays, preventing it from percolating into the ground, why do not the large drifts in the open, which he says form the main reservoirs of the streams, also absorb their own water and prevent it from running off?

The fallacy of Colonel Chittenden's arguments in this respect is obvious. It is, of course, true that if a warm rain comes upon the snow blanket in the woods, carrying it off in a short time, the resulting flood may be greater than if the forest had not been there to retain the snow; but it is equally clear that in the latter case the earlier spring floods would have been increased. If a given amount of snow has to be carried off into the streams, it is obvious that the flow of the streams will be more regular if the period of melting is extended, and this is the effect of the forests.

A further instance of illogical reasoning is found in Colonel Chittenden's reference to the great floods which occurred in the State of Washington. He says: "The great flood of 1906 in this section was a perfect demonstration not only of the vast intensifying effects of forests upon floods due to snow melting, but of the utter helplessness of the forest bed, when saturated with long rains, to restrain floods." It will be clear, however, upon reflection, that this flood is no demonstration of any "intensifying effect." It simply demonstrates that there may be heavy floods from forested areas. If those forests were cut down, that same flood might, and probably would, have been much more violent. Colonel Chittenden here apparently forgets the difficulties in studying this

problem which arise from the fact that the effect of the forests can not be separated from the other elements entering into the problem.

Similarly inconclusive is the statement about the flood of the American river compared with Puta Creek in California. Watersheds differ not alone as regards forests, but in other respects. The facts stated simply seem to show that in this case the forests did not regulate its flow to an extent sufficient to counterbalance other factors. For instance, if the writer is correctly informed, the slopes of the Sierras are steeper than those of the coast range. Again, the shape of the drainage area is a matter of considerable importance with reference to the maximum rise of water at a given point.

The writer has not had the opportunity to study to any extent the conditions in the Rocky Mountains, but he observes that Prof. L. G. Carpenter, of the Colorado State Agricultural College—than whom there is no more competent authority—in his paper on "Forest and snow" comes to the conclusion that (a) * * * "the greater the amount of forest cover the less violent the daily fluctuation, the more uniform the flow throughout the day and throughout the season and the later the stream maintains its flow. (b) The loss of the forest cover means more violent fluctuation during the day, greater difficulty in regulating the head gates and keeping a uniform flow in ditches, and hence an additional difficulty in the economic distribution of water; also the water runs off sooner, hence the streams drop earlier in the summer, and, on account of the lessening of the springs, the smaller is the winter flow. (c) The preservation of the forest is an absolute necessity for the interest of irrigated agriculture."

Colonel Chittenden, however, after devoting so much space to considering the effects of forests upon extremes of flow, does not on the whole take his own arguments seriously, for later on he says: "In the records of precipitation, wherever they exist, will be found a full and complete explanation of every one of the floods that have seemed unusually frequent and severe in recent years." After citing the conditions, he goes on to say: "Similar conditions prevail in every great flood, and the true explanation is found in them and not at all in the presence or absence of forests on the watersheds."

Reference has already been made to the fact that the amount and distribution of rainfall are the most important factors affecting the flow of streams, yet it is quite unreasonable to conclude that on that account the forests have no effect at all.

These quotations are cited, however, to show the apparent contradictions in Colonel Chittenden's arguments.

It would take too long to analyze in detail the remainder of Colonel Chittenden's paper and to criticize his many statements. If his views, however, have weight, attention should be called to one statement which he makes with reference to erosion. He states (page 955 et seq.) that the sediment carried into the Gulf of Mexico by the Mississippi "all comes from the uplands far and near, but particularly from the more remote and hilly regions. This load is in the nature of through traffic. The local freight picked up from a caving bank is mainly discharged at the next station. It follows, therefore, that if the banks of a stream were revetted from the Gulf to Pittsburg, the Falls of St. Anthony and the mouth of the Yellowstone, the quantity of sediment passing into the Gulf would not be diminished a particle."

As the quantity of sediment carried into the Gulf each year is exceedingly large, Colonel Chittenden admits the great erosion from the mountain slopes. We do not agree with him, however, in the statement quoted. A river picks up sediment where the velocity of the water and the size of the grains of sediment admit, and a reduction of velocity causes the deposition of sediment, beginning with the heaviest particles. The river cuts away a bank here and deposits a bar there, and much of its load is, as Colonel Chittenden states, in the nature of local freight. The important point, however, is that all this freight is moving downstream, and it would seem scarcely reasonable to suppose that under this continual movement downstream the only silt to find its way into the Gulf is that which comes from the extreme sources.

In contradiction to the above statements, Colonel Chittenden says: "It is incontestably true that whatever restraining effect forests have upon run-off is greater upon the lowlands than upon steep mountain sides." This is a good illustration of the character of statement with which this paper abounds, positive statements given entirely without proof and in contradiction to all experience and to the best authorities. It would seem to be reasonably clear that since on steep slopes there is more tendency for the water to run off than on moderate slopes and flat land, whatever restraining effect the forest exerts

would be greater on steep slopes than elsewhere. Seeing that if the land were absolutely level there would be no tendency at all for the water to run off, so that it would all either percolate or be absorbed, or evaporate, and seeing that flat lands upon which forests will grow are generally suitable and must sooner or later be used for cultivation, and seeing, also, that Colonel Chittenden has asserted that newly plowed land has probably a retentive capacity greater than the forest ground, the difficulty of reconciling some of these statements will be seen.

In the recent work of Huffel, "Economie Forestiere," for example, a detailed discussion of many of these points will be found, and the fallacy of Colonel Chittenden's last remark above quoted is there abundantly shown.

Colonel Chittenden refers to some foreign publications, particularly to the reports of the Tenth International Navigation Congress, held at Milan, in 1905. With reference to this he says: "While all the writers heartily favored forest culture the opinion was practically unanimous that forests exert no appreciable influence on the extremes of flow in rivers." The important part of this quotation is the first clause, and not the last. It is true, and it is a very significant fact, that all the writers urged the preservation of the forests on the mountain sides, or precisely what is contemplated by the White Mountain-Southern Appalachian bill. As foreign testimony may be of value in this connection, as showing the dependence of the interests of navigation upon the preservation of the forests, it may be worth while to give extracts from some of these reports.^a

Mr. Lafosse, the French delegate, says:

"If the destruction of forests is to be deplored it is most of all on the mountain that the cutting away of timber is to be feared. It is not alone the supply of the springs and the discharge of the streams which are in danger; it is the very existence of the rivers themselves. The stream which can be utilized disappears, to give place to the devastating torrent.

"The soil swept bare of its forests, exhausted by the abuses of grazing, loses quickly its vegetable stratum. Washed periodically, and carried away by melting snow and summer storms, it is soon disaggregated. The waters run toward the low points, rolling before them gravel and boulders, and even tearing out loose sections of rock. A thousand rivulets cut out beds, the torrent is formed. Scours begin, the banks are broken down, and a mass of mud, stones, and rocks invades the valley, destroying everything as it passes."

Mr. Wolfshitz, a delegate from Austria, while admitting that excessive floods are not appreciably checked by forests, writes as follows:

"For economical reasons reafforestations will have to be confined to the steeper mountain slopes, which are of little use for other cultivation. Here the forest will have a beneficial influence by making the soil firmer and more compact and by preventing erosion and washing down, and thus any excessive alteration and the formation of detritus, which would shoal and silt up the water courses. Such forests further retard the melting of the snows in spring and lessen the violence of spring high water. It is thus advisable in the interests of navigation to spare and to attend to the forest. There is no simpler, cheaper, nor more effective means for securing the mountain slopes and for keeping the pebble shoals down. In this respect, forests have incontestably had a beneficial influence upon the floods of the large rivers. Beyond this, however, no further measurable influence upon the high waters of rivers can be credited to them.

"As regards the occurrence of high floods in the large rivers, the forests can not have any noteworthy influence. As regards the increase in the ground-water level and in the replenishment of springs, the forests have, in the plains, no more influence than the open ground, and it is only in the mountains that this action can be rated at any higher figure. In the mountains, however, the main office of the woods will be to prevent the denudation and erosion of the surface, the formation of detritus, and the silting up of the river beds with mud, sand, and pebbles."

Mr. Riedel, of Vienna, is very emphatic as to the benefits of forests. He shows the terrible results which have been brought about by their destruction in various parts of Europe, and with reference to Germany states that "in Germany, also, reasonable bounds were not everywhere kept to, and the effects of the progressing deforestation made themselves apparent on the one hand in scarcity of timber and on the other in the impoverishment of perennial

^aThe translations were made abroad and the quotations are given just as printed.

springs and the alarming lowering of the mean water level of German rivers, and not less so in a gradual increase in the dryness of the ground, caused by the fall of the level of the underground waters.

"The unquestioned circumstance, that a large number of rivers now carry down more loose material than formerly, is a consequence of the extensive denudation and careless clearing of the plantations. The slopes of the hills lose a large part of their fruitful soil, and in many cases earth slides and even extensive subsidences of whole slopes take place, while considerable areas of ground in the valleys are smothered up and rendered useless.

"The loose material which the tributary brooks carry into the main streams ceases to be carried onward as the declivity becomes less steep, and in consequence fills up their beds. The streams are then obliged to seek out new courses, by which the most fruitful ground is devastated and the whole bed of the valley is gradually transformed into a barren layer of loose stones. This drawback affects not only the mountain dwellers, but, in so far as the waters are not able to deposit their loose suspended material in large basins on the way, the population of the lower-lying and well-tilled valleys also. Here the damages further include the circumstance that, by reason of the often elevated position of the river-bed, overflow waters are very difficult to get rid of.

"Proofs of the foregoing, and especially of the last-mentioned circumstance, are afforded by a large number of river valleys. This condition of things is of importance in the cases of those river or stream channels which by the formation of weirs are to be made serviceable for purposes of inland navigation, earth slides, damages to river banks, and inundations did not take place, though at a distance from the channel, lie at a lower level than the latter, are swamped to the most damaging extent.

"The foregoing is not intended to convey the idea that previous to deforestation, earth slides, damages to river banks, and inundations did not take place, but it is intended to show that since the decrease of the forests all these disadvantages have increased to a serious and disquieting degree."

Mr. Lauda, of Vienna, compares two similar watersheds of about the same area in Austria, one being much more heavily wooded than the other. He thinks the forests may not exert much influence in high floods, but concludes as follows:

"If, now, the final judgment on the subject of the influence of forests on the regimen of streams be unfavorable to the forests to this extent, that there are denied to it certain of the properties attributed to it generally, it does not follow from this that it is necessary to oppose the rewooding of arid surfaces, the replanting of the basins of streams, or the maintenance of plantations of trees. The general utility of the forest is so well settled, the extraordinary appreciation in which it is held, as a means of protecting the soil against landslides, is so firmly established, its great advantageousness, especially for the spring district, in holding back earth thrusts and reducing the amount of sediment carried by rivers so important, that these reasons alone justify fully the greatest possible promotion of forest culture."

Mr. Ponti, of Italy, seems to have no doubt that forests on steep slopes are useful in the interests of navigation. He says:

"In Sicily, the consequence of cutting away the forests on a vast scale in the province of Messina has been also to raise sensibly the bed of the streams, and many of these beds are now above the adjoining fields."

Mr. Keller, of Austria, thinks that forests affect the regimen and discharge of rivers only to a slight extent except in mountainous regions, regarding which he says:

"However, there is no doubt that in many cases deforestation has contributed to the erosion of the mountains and to the deposit of their soil at their foot, as also to an unfavorable change in the conditions of flow and drainage of the waters. This remark applies equally to the regions of high mountain ranges as to the Mediterranean basin. There are also the formation of a cohesive soil takes too long to make good the loss caused by a sudden shower."

Mr. Lokhtine, of Prussia, does not discuss particularly the effect of mountain forests, but among his conclusions is the following:

"(1) Forests form a beneficent factor, acting favorably on the general abundance of water in a country, and particularly on the supply of streams and rivers. That is why the destruction of forests should be considered as hurtful and dangerous."

These extracts show that foreign authorities are unanimous as to the benefits of forests on the mountains upon the flow of streams and the interests of navigation.

It will not be attempted to discuss Colonel Chittenden's remarks with reference to reservoirs, as these are not here under consideration.

Finally, it must be remembered that the acquirement by the Government of forest reserves in the Appalachian and White Mountains will be of benefit to the navigation of the streams not simply in proportion to the area of these reserves. By acquiring a foothold, the Forest Service will be able to demonstrate to owners of adjoining tracts the benefits of wise forest management, and will be able to cooperate with them on the ground in using similar methods in their own forests. The Government, also, for the same reason will be able to restrict forest fires, not only on the government reserves but on private lands. The effect of the government reserves, therefore, will be much larger than in proportion to their area, and by wise management and by cooperation with private owners not only will erosion of the ground be prevented and the flow of the streams favorably affected, but the timber supply will be conserved.

UNITED STATES ENGINEER OFFICE,
Seattle, Wash., January 12, 1909.

Hon. CHARLES F. SCOTT,

*Chairman Committee on Agriculture,
House of Representatives, Washington, D. C.*

MY DEAR SIR: Your letter of the 4th instant, inclosing a paper by Dr. George F. Swain, with a request for my opinion thereon, has only just arrived, the delay being doubtless due to the heavy weather prevailing along the Northern Pacific roads.

As you are doubtless anxious for an early reply, I will dictate one at once, without taking time for a more careful consideration of Doctor Swain's paper. I therefore ask your indulgence with the somewhat disjointed and fragmentary character of my reply. I should be glad to put it in better form.

Taking up seriatim Doctor Swain's criticisms, I note that in the first place he says "the great majority of engineers conversant with the subject believe that forests act as equalizers of stream flow." This statement would be more correct if he said the great majority of engineers not conversant with the subject; i. e., with the subject of stream flow in our navigable rivers. I do not myself know a single hydraulic engineer of wide experience in these matters who believes that forests have any particular effect in diminishing great floods or in preventing extreme low waters. I believe this also to be the opinion of foreign engineers. There is a very wide sentiment in both countries to the contrary, but this sentiment is very largely explained by the persistent arguments of forestry advocates, to which hydraulic engineers take no particular exception, because they do not wish to go on record as opposed to forestry extension.

In this connection I will pass to the last portion of Doctor Swain's paper, in reference to foreign opinion on this subject. I have searched this matter a great deal, and I believe that I am entirely correct in saying that the schools of thought on the subject in Europe may be divided into forestry advocates and river engineers. I am unable to find among the latter any that advocate forests as a corrective for the extremes of flow in our rivers. Doctor Swain cites the report of M. F. Valle as having made no impression at the time. I am unable to say what impression it had, but the report itself is a very forcible one, and cites the opinion of a number of other hydraulic engineers of prominence who coincide with M. F. Valle's views. As a matter of fact, this subject was under careful discussion at that time, and there were different views, just as there are to-day upon the subject. But when it came to the question of practical work the French engineers summarily rejected the idea that the forests could be relied upon in any degree to simplify the problems of floods in French rivers.

In the exceedingly elaborate investigation instituted by Napoleon III, as a result of the extraordinary flood of 1856, this very matter was brought forward by forestry advocates and was considered by the engineers. Their finding was that whatever value forests might have locally in preventing erosion of steep slopes, they could not be relied upon in any degree to diminish the great floods from which France had just been suffering, and that any measures which might be taken in the line of reforestation would have no appreciable effect. Their report cited a very elaborate and exhaustive work upon the floods of French rivers, going back over six hundred years, in which it was conclusively shown that former floods were larger than those at the present time, the progressive

diminution of the floods in the river Seine with the settlement of the country being particularly noticeable. This practical example of what the real technical thought of river engineers on this subject was has been followed ever since. So far as I am aware, no project of river improvement, either for flood protection or low water in their navigable rivers, has embraced reforestation as an essential part, or even any part at all.

Doctor Swain quotes in extenso from the papers read before the Milan congress, but a careful reading of these papers will show that the arguments in favor of forests are based, in great part, upon the question of erosion and the torrential flow of mountain streams. They do not touch the question of control of our great rivers. Doctor Swain's reference to M. Lauda's report upon this subject is certainly not indicative of that author's views, as your committee can readily see from reading the inclosed translation of his report upon the great flood of the Danube in 1899. M. Lauda makes it very clear that forests on that watershed had no appreciable influence in diminishing the flood; in fact, the largest run-off came from those very portions which were most heavily wooded.

Summing up this particular matter, it is my opinion that the views of river engineers may be correctly expressed as follows: That they are heartily in favor of the creation of forests for the preservation of our timber supply and, possibly, also in the prevention of erosion in particular situations, but they have no faith whatever in the efficacy of forests to simplify the problems of river control.

I now take up the point of which considerable is made by the forestry advocates, and that is that it is not the extreme floods and low waters that are of so much importance as the frequency of moderate floods. Doctor Swain calls these extreme conditions "freaks." I am quite unable to appreciate the force of this argument in even the smallest degree and I will try to make my reasons therefor clear to you. It must necessarily be the extreme conditions which engineers have to consider in the control of our rivers. Take the city of Pittsburg, for example. That city could not be satisfied with any measure of flood control which does not take into account the great floods. The forestry advocates might say to that city, if you will give us an appropriation to reforest the Monongahela watershed, we can assure you that the average moderate floods of that river will be diminished in height and in frequency by 10 or 15 per cent of what they are at the present time, and you can then get along by constructing protection works that will meet this new condition, letting the "freaks" when they come along, take care of themselves. Now, any such proposition as this is manifestly absurd, and the city would at once reply that the great damage which has been done in its past history, the great inconvenience suffered, have come from these particular extreme floods, which are denominated "freaks." The city would say that its people would not be satisfied with any scheme of protection that did not provide for these conditions. Inquiring of the forestry advocates as to whether they could have any assurance that these "freaks" could be eliminated by reforestation, the reply must inevitably be that they could not. The city would then probably say, "It seems to us that it would be better to take this extra money for reforestation and add it to our protection works and make these strong enough and high enough to keep the 'freaks' out. If we can be assured of local protection against the extreme floods, we shall not worry very much about those that are smaller; they may cause some inconvenience, but we will worry along with them very well."

In like manner exactly the same reply must be given to any attempt to apply this agreement to the levees of the Mississippi River and also to low-water navigation of our streams. The reply of the boatmen must inevitably be that any scheme of river control must include the "freak" years; that they do not want their boats laid up every now and then, simply because an exceptional year comes along which pulls the water down lower than the "mean" of a certain number of years. They say that if provision is made for these extreme low years all the others will take care of themselves.

I think that any practical man must take this view of the case, that in our problems of river control it is the extremes that must govern; and it is now admitted, particularly since my paper appeared, that forestry has no power to mitigate these extremes in the slightest degree; that they were just as great before the forests were cut off as they are to-day, and there is some evidence that they were greater.

But the very argument itself that deforestation has made moderate floods more frequent than they used to be stands without proof. Mr. Leighton's re-

searches have been cited. I have examined his numerous tables and I can only give it as my professional opinion that his argument is hopelessly defective for lack of sufficient data. On the Ohio River, for instance, he takes a period of twenty-four years, divides it into two twelve-year periods, and shows that in the second of these periods moderate floods were more frequent than they were before. This period runs from 1876 to 1900, beginning long after the bulk of the deforestation of the Allegheny and Monongahela watersheds had taken place.

From information recently collected at the United States Engineer office at Pittsburg it appears that the change in forest areas on these two watersheds during this entire period amounted to barely 6 per cent of the area of the watersheds, and that the mean change from the middle of one period to the middle of the next was only 3 per cent. Manifestly to draw any conclusions as to the effect of such a change upon the flow of these streams is absurd. It is not at all unlikely that another period of twelve years will show a reversal of the above conditions.

The same is also true of the Connecticut River watershed, where it is an admitted fact that the forest area is now even more extensive than it was forty or fifty years ago. I have not the data on hand to test Mr. Leighton's findings in regard to the Tennessee River watershed, but, in any case, there is one hopeless lack of data, and that is the relation between each particular flood and the rain that produces it. It is not a question of "means;" it is a question of specific cases. It often happens that a smaller rain, coming upon a watershed already soaked with previous rains, will produce a greater flood than a much heavier rain upon the same watershed when the latter is dry, and, unless these conditions are known and the manifold circumstances attending them, any such conclusions as Mr. Leighton has drawn, when applied to particular local watersheds, are unwarranted. In my paper I was very careful not to run into this error. I took only the broad, general results as summed up in the final flow of our great rivers, and from them it was conclusively shown that deforestation has not diminished the extremes of flow at all.

In regard to the question of erosion I give the result of my own observation, and that is that it is almost universally a question of cultivation. A tree has no power to prevent erosion, except that portion which is directly on the ground, and if the tree is cut down and removed the condition of the ground remains as it was before, except where logging roads or chutes are constructed for the removal of the timber. When the cutting of timber is immediately followed by undergrowth, the latter is in every sense as effective, and often very much more effective, in preventing erosion than the timber itself. It may be replied that trees are cut down only to give place to cultivation and that, therefore, deforestation and tree cutting mean the same thing; but they do not by any means, and there are vast areas all over our country to-day that are deforested, i. e., the virgin timber has been removed, but have not been reduced to cultivation at all. In the matter of preventing erosion of our fields, it is a question of what kind of cover will best serve this purpose and meet the other uses to which the soil is to be put. If that cover is a forest, let it be adopted, but do not attempt to establish any hard-and-fast rule of general application that the removal of our forests leads to the erosion and ruin of our fields. It does so in only special cases where the soil is extremely unstable and liable to wash away upon any disturbance.

Doctor Swain states, on page 6, that I have not proven that forests never diminish great floods, or that they probably do increase them somewhat, and that it is therefore only a matter of my personal opinion. In reply to this I invite your attention to the tables showing the great floods on our principal rivers, as far back as records have been kept, and you will there find that both the great floods and the extreme low waters were quite as great and quite as frequent in the earlier periods as they are at the present day.

Doctor Swain's criticisms of my reference to the reservoir scheme projected for the river Rhone are not well taken, in the absence of information on his part. If he will read the remarks of the French engineers upon this subject, he will see that they found, after very exhaustive study, that the system of reservoirs they proposed—with outlets permanently opened—would have aggravated the flood which actually occurred in the lower portions of that valley in 1856.

The doctor's criticism of my reference to the flood of 1908 in western Montana (p. 9) is also not well taken. It was not a matter of opinion at all, but a practical, logical proposition, as capable of demonstration as any proposition in mathematics.

At the bottom of the same page Doctor Swain touches upon the real crux of this whole question, and that is climatic or atmospheric conditions. Every flood is produced by rain or snow. No flood was ever produced in which the rain or snow did not descend in very considerable quantities. It is perfectly demonstrable that the proportion of any precipitation (which is capable of producing a flood in our large rivers) that can be held back or controlled by a forest bed is relatively an insignificant quantity. It is this fact—that the heavy rains completely drown out and exhaust the storage capacity of the forest bed—that renders it nugatory in diminishing the height of the flood. It no doubt has some influence when the first rains come, after a period of somewhat dry weather, but in a short time its capacity is to all practical purposes exhausted and it cuts no figure whatever in restraining the subsequent run-off.

The question, therefore, comes back to rainfall, and unless the forestry advocates can show that deforestation has a direct and powerful influence upon rainfall their whole position would seem to fall to the ground. I believe that it is now well recognized the world over that climatic changes do not result from the clearing of the land. I can produce pages of records of the rainfall in our own country that would seem to prove this conclusively, and I quote here an item which I happened to have at hand from Professor Abbé of the Weather Bureau, which is exactly in point.

"There is no well-authenticated case of an appreciable change of climate within the past two thousand years. The researches of Eginitis on the climate of Greece seem to establish this principle beyond doubt. Neither is it possible that any change on the surface of the earth due to man—such as deforestation, reforestation, agriculture, canals, railroads or telegraph lines—can have had anything more than the slightest local effect on climatic phenomena that depend upon the action of the whole atmosphere."

The examples cited by Doctor Swain of expenditures by foreign governments for reforestation have no pertinence to the point here in consideration. It is perfectly true that all enlightened countries expend money for this purpose, as they should, and as it is to be hoped our country will do; but it is for the purpose of raising forests and not for the improvement or control of our great rivers. In France they have been resorted to extensively for the purpose of preventing erosion on mountain slopes, where extensive deforestation and ill-advised cultivation were undertaken upward of a century ago.

In reference to my argument concerning the low-water flow of rivers, some misunderstanding has resulted, due to a failure to comprehend what I actually said. In no case have I depreciated the value of springs which are, of course, of the very highest importance at such times; but I simply said that the difference between the low-water flow of a spring or stream when forests covered the ground and what it is now, is a relatively very small quantity, compared with the flow of the river itself.

The real springs upon which our streams rely in time of low water remain nearly permanent and respond very slowly to the effects of rainfall. They are deep-seated springs that flow for long distances through the earth, and often emerge to the surface far from their source of supply. Such springs are found in all parts of this country and in all parts of the world, and many towns and cities rely upon them for their supply. I have been unable to find any evidence that these permanent springs have suffered materially in volume from deforestation of the country. The shallower springs, those which come from near by and respond quickly to rainfall and drought, are the ones that dry up to such an extent in the low water season. They used to dry up also before the forests were cut away, and do so in forests to-day, as anyone can see by examining springs in the early part of the season and then again in the autumn. It is this class of springs which has suffered, if there has been any diminution by the clearing of the country. But it is right here that our forestry friends jump at the conclusion, which is by no means warranted, that the removal of the trees is the cause of this diminution and also the cause of the diminishing supply of wells. They never stop to consider the enormous demand upon these waters, which has accompanied the settlement of the country and which is increasing all the time. The one item of locomotives in the United States takes up 170 cubic feet of water per second or a stream twice as large as the Monongahela River in extreme low water. Towns require 100 gallons per day per individual; every farm has its wells and the drain of water for these varied purposes is something enormous. It has been conclusively proven that wells, by being constantly drawn upon, lower the water where no change whatever has taken place upon the surface of the ground. In fact, it seems reasonably cer-

tain that, if all these demands for various purposes were to be shut off completely, if such a thing were possible, our springs and wells and little streams would show a material increase in flow. These losses are, of course, not at all due to the presence or absence of forests and can not be affected by anything which may be done in the planting of trees.

In like manner, the assumption that the little mill of former times was abandoned because of low water is entirely erroneous. Take any one of these mills and trace its history, and in nine cases out of ten business and not physical conditions will be found to be the explanation. The advent of steam and cheaper methods of manufacture have done away with the little mill, and if steam were abolished to-day the little mill would most assuredly come back again without delay. So in all these cases, whatever the diminution of the flow of small streams may be, it can not be chargeable entirely to forests, but has other good and more important explanations.

There is, however, one thing which undoubtedly increases the dry-season flow in the open country somewhat over that in the forest, and that is the summer showers. The roads and ditches, the pavements, and roofs of houses do shed such showers more effectually than the forests at such times, and undoubtedly the summer run-off in the streams is then greater in the open country than in the forests. This is precisely what I referred to when I said that the increased run-off from showers very likely made up the difference in the low-water flow of springs. In proof of this I appeal to the records of our large rivers, which show that the low-water flow under present conditions is no lower than it used to be when forests covered the country. In fact, to cite an example of the Monongahela River, if all the demands for water upon that stream which have grown up since 1856 (a very low-water year) were cut off, the flow of that stream in the great drought of last fall would undoubtedly have been greater than it was in the year above mentioned.

I will not go at length into Doctor Swain's criticism of my argument in regard to the influence of forests on snow melting, as this applies mainly to the Rocky Mountain region and the Pacific coast and has a relatively small bearing upon the Appalachian forests. As to the argument itself, I believe it will come out of this discussion as permanently established as any fact in science. You will find, when you come to read some of the papers which it has called forth, that the state engineer of Wyoming confirms it in its entirety; certain engineers of Los Angeles give comparisons of four rivers in the Sierra Nevada Mountains and show that the deforested watersheds have the most regular and most copious supply, and you will also see another paper in which the same results are set forth in the mountains of Nevada.

The annunciation of this theory has caused some surprise and a good deal of opposition, but it has not been shaken by anything that Doctor Swain has said, and I am perfectly willing to rest upon the simple statement of facts put forth in my paper.

The same is also true as to the forests of this coast. In nothing have I been so much surprised as in becoming acquainted with the torrential character of these streams. If there is a place on the face of the earth where forests ought to regulate stream flow, it is right here. As a matter of fact, these streams respond to storms in a way that I have never known to happen in any country cleared of forests. It is undoubtedly due to the effect of the forests in spreading the snow out in such vast areas, so that the rain and warm weather get at it in all directions; and also to the fact that through long periods of time the water has created little channels underneath the débris, so that it finds its way to the streams much more readily than one would imagine.

The fact stands out very clear and undisputed that, in this region of protected watersheds, floods and low waters are just as pronounced as in our eastern cultivated country, except where low water is kept up by the supply from the glaciers.

In regard to the caving of our river banks, I would expressly request that my statement of that case be studied carefully, because I believe it to be substantially correct. Of course, the great moving of silt in our rivers is from the local caving of banks, but it is always in the nature of picking up here and putting down there. It does not contribute to the total outflow from the mouths of the rivers, because these valleys, from year to year, are gathering sediment all the time.

As to the statement on page 19, second paragraph, which is criticised by Doctor Swain, I will simply say that if any one will take a board and put sand, soil, or any other absorptive material on it, and saturate it with water,

weight the water, and find out how much of it runs off when inclined at an angle of 5 degrees and also how much when it is inclined at an angle of 45 degrees, he will at once agree entirely with the author's statement.

Referring once more to the question of filling up our streams through erosion, of which so much is made in recent articles on forestry, I have to say that in my paper I challenge directly the statement so frequently made that our own navigable rivers are silting up as a result of deforestation. That challenge has remained unrepiled to, because the facts prove the statement untrue. Very interesting in this connection is a recent investigation by the Geological Survey^a in connection with Mr. Leighton's proposed reservoir system, in which it was shown that under present conditions, after deforestation has progressed to a very great degree, there is absolutely no danger that these reservoirs would become inoperative for many hundreds and even thousands of years from filling up with sediment. When this fact is considered, it is easily seen how slight an influence such sediment can make upon a great river like the Ohio, which can easily wash it all out and a thousand times as much, and still not tax its energy to the limit. If the erosion from these watersheds is now so small, after deforestation has taken place on perhaps 50 or 60 per cent of the watersheds, why should we assume that it will become dangerous with the removal of 15 or 20 per cent more of the forests.

To sum up this somewhat rambling letter, I wish to say that my point in the whole discussion is simply this, that it is to-day an unproven fact—and I thoroughly believe incapable of being proven—that anything which it is possible to do in the line of reforestation will simplify our river problems in the least degree. It was, in fact, the real purpose of my paper to call the attention of the country to this matter in connection with its future policy in the creation of our forests. The proposed Appalachian Forest Reserve will cost many millions of dollars. If it is being undertaken in the interests of river improvement, the people should be thoroughly informed as to whether the promised improvement will result. If it is found, upon investigation, that the creation or preservation of these forests will not simplify these problems or reduce the cost of navigation works and flood protection in any degree, then, manifestly, it is not a proper expenditure for this purpose. I thoroughly believe in the necessity of inaugurating a comprehensive policy of creating and extending our present forests as far as it is practicable, but it seems to me that it ought to be done for the *true* purpose which these forests are to serve.

In my paper I pointed out another argument, which has so far not been replied to by anyone, and that is that, with any practical extension of our present forests it would not be possible to produce a sufficient result to make any appreciable effect upon our streams, even granting the full force of the forestry argument. We can not, in the very nature of things, have a greater area of woodland than we now have, namely, about one-third of our total area east of the Mississippi River. The necessities of settlement and cultivation will rather require it to be reduced.

If I may make a suggestion in this connection it would be this: This important subject has never really been brought up for general discussion; until within the last few months it has always been advocated from the pro-forestry side alone. Within the next few months there will be printed the entire discussion of my paper, including arguments by Messrs. Pinchot, Leighton, and Swain, and Professors Smith and Willis of the Geological Survey, besides several prominent engineers. It will include also my closing argument on the subject.

It would seem very desirable that this information should be gotten before your committee before it takes final action in this matter, and it would seem, further, to be very desirable that instead of immediate action the whole matter should be referred to a commission in which the engineering profession shall have at least an equal representation. The trouble with the forestry advocates is that they have a "cause" to promote, and the promotion of this cause does not leave them in that free and unbiased state of mind which is required for an impartial investigation of a subject like this.

The future development of our forests is going to cost many millions of dollars, and it would seem to be a wise step to pursue the same course in this as in any other great undertaking, like the Panama Canal, for instance, by subjecting it first to a full and impartial investigation in order that its varied

^a See Engineering News, Dec. 10, 1908, p. 649.

bearings may be fully disclosed. There is manifestly no necessity for precipitate action. In spite of all that the pessimist may say, our country is not going to ruin if the Appalachian bill is not passed at this session of Congress, and it is important, in the interest of intelligent legislation, that a very thorough investigation of the whole subject be made before any definite policy is adopted.

I have been greatly impressed with the immense drawback to the country, due to the situation of some of our forests, which are so remote and inaccessible as to be almost valueless, and it has seemed to me that any intelligent policy must include the restoration of our forests where they used to be and in these situations that are most accessible and most convenient to the homes of the people.

I am in no sense opposed to the Appalachian forest reserve, so far as such a reserve satisfies the requirements of a source of timber supply, but when it comes to creating such a reserve on the ground that it will simplify or cheapen the problem of flood protection and navigation in our navigable rivers, the matter requires further investigation.

Very respectfully,

H. M. CHITTENDEN,
Lieutenant-Colonel, Corps of Engineers.

I forgot to refer to the effect of snow upon the forest bed in our eastern deciduous forests. The fallen leaves of the previous year are pressed down perfectly flat and form a partially water-tight lining between the snow and the ground, which not only interferes with absorption of such melting as may take place from underneath, but materially accelerates surface run-off into the streams.

ACQUIRING LAND FOR THE PROTECTION OF WATERSHEDS FOR THE
CONSERVATION OF NAVIGABLE STREAMS.

FEBRUARY 3, 1909.—Committed to the Committee of the Whole House on the state
of the Union and ordered to be printed.

Messrs. WEEKS and LEVER, from the Committee on Agriculture,
submitted the following

R E P O R T.

[To accompany S. 4825.]

The Committee on Agriculture, to which was referred various bills
for the protection of the watersheds of navigable streams, submits the
following report, to accompany Senate bill 4825.

After a thorough discussion of the purposes to be accomplished it
was deemed advisable to report the accompanying bill, as meeting
more fully than any other the needs of the situation.

Section 1 proposes to give the consent of Congress to each of the
several States of the Union to enter into any agreement or compact
not in conflict with any law of the United States, with any State or
States for the purpose of conserving the forests and water supply of
the States entering into such agreement or compact.

Section 2 appropriates the sum of \$100,000 to enable the Secretary
of Agriculture to cooperate with any State or group of States, when
requested to do so, in the protection from fire of the forested water-
sheds of navigable streams, and the Secretary is authorized to stipu-
late and agree with any State or group of States to cooperate in the
organization and maintenance of a system of fire protection on any
private or state lands within such State or States and situated upon
the watershed of a navigable river.

The section further provides that no such stipulation or agreement
shall be made with any State which has not provided by law for a sys-
tem of fire protection, and that in no case is the amount contributed to
any State to exceed the amount appropriated by that State for the
same purpose.

Section 3 provides that the Secretary of Agriculture may, for the
protection of the watersheds of navigable streams, on such conditions
as he deems wise, agree to administer and protect for a definite term
of years any private forest lands situated upon any watershed whereon

lands may be permanently reserved, held, and administered as national forest lands, and that in such case the owner shall cut and remove the timber thereon only under such rules and regulations as will provide for the protection of the forest in the aid of navigation. The section provides that in no case is the United States to be liable for any damage resulting from fire or any other cause on such lands.

Section 4 provides that from receipts from the sale or disposal of any products or the use of lands or resources from the public lands now or hereafter to be set aside as national forests which may hereafter be turned into the Treasury of the United States and which are not otherwise appropriated, there shall be available \$1,000,000 for the fiscal year ending June 30, 1909, and not to exceed \$2,000,000 for each fiscal year thereafter, to be used in the examination, survey, and acquirement of lands located on the headwaters of navigable streams, or those which are being or which may be developed for navigable purposes, and further provides that the provisions of this section shall expire by limitation on June 30, 1919.

This section has two features not included in any of the other bills referred to the committee. The first is, that the proceeds from the present national forests, so far as they are at present unappropriated, are to be turned to the purchase of forest lands to the amounts above mentioned. The second feature is, that instead of limiting the acquisitions by purchase or otherwise for this purpose to any particular region or regions, such as the Southern Appalachian or White Mountain region, lands may be acquired on any watershed, so far as they fall within the purposes of the bill.

Section 5 provides for the establishment of a National Forest Reservation Commission, to be composed of the Secretary of War, the Secretary of the Interior, the Secretary of Agriculture, one member of the Senate, and one member of the House of Representatives, the object of the commission being to consider and pass upon such lands as may be recommended for purchase and to fix the price or prices to be paid for such lands. It further provides for limiting incumbency and for filling vacancies in the commission.

Section 6 provides for an annual report to Congress of the operations and expenditures of the commission.

Section 7 authorizes the Secretary of Agriculture to examine and locate lands to be recommended to the National Forest Reservation Commission for purchase. The section also provides that a report shall be made to the Secretary of Agriculture by the Geological Survey showing in what way the control of such lands will promote or protect the navigation of streams on whose watersheds they lie.

Sections 8 and 9 provide the method by which lands may be acquired by the Secretary of Agriculture after they have been approved by the National Forest Reservation Commission.

Section 10 provides that the owner of the land from whom title passes to the United States may, under certain conditions, reserve the minerals and merchantable timber within or upon such lands at the date of conveyance, and provides the method by which the removal of such minerals or timber may thereafter be accomplished.

Section 11 provides for the sale of small areas of agricultural lands which may of necessity or by inadvertence be included in tracts acquired under this act.

Sections 12 and 13 provide for the management as national forests of the lands so acquired and describe the limits of civil and criminal jurisdiction over them.

Section 14 provides that 25 per cent of all moneys received from any national forest acquired under this act shall be paid at the end of each year to the State in which such national forest is situated for the benefit of public schools and public roads.

Section 15 provides for the necessary expenses of the commission and prescribes the manner of auditing and paying of the same.

SCOPE OF THE BILL.

This bill is general in its scope, and permits the acquirement of lands in any part of the United States where such acquisition can be shown to be advisable to the National Forest Reservation Commission, after the Geological Survey has determined that such acquisition will promote or protect the navigability of streams on whose watersheds the lands lie.

INCOME FROM THE NATIONAL FORESTS TO BE USED.

The funds to be used under the provisions of this bill are a prescribed amount of those which come into the Treasury from the sale of the products or the use of the resources of the national forests so far as they are not now appropriated. The law at present provides that 25 per cent of the money so received shall be paid to the States or Territories in which such forests are located, for school and road purposes. It is to be particularly noted that this bill does not change that plan, but rather extends it to the States or Territories in which national forests may be acquired. The net amount received from the uses of the national forests for the fiscal year ending June 30, 1908, was \$1,341,691.39, and for the present fiscal year is estimated to be \$1,500,000.

RELATION OF FORESTS TO THE USE OF INLAND WATERWAYS.

The relation of forests to the use of the inland waterways is shown by the following quotations:

Our river systems are better adapted to the needs of the people than those of any other country. In extent, distribution, navigability, and ease of use they stand first. Yet the rivers of no other civilized country are so poorly developed, so little used, or play so small a part in the industrial life of the nation.^a

The first requisite for waterway improvement is the control of the waters in such manner as to reduce floods and regulate the regimen of the navigable streams.^b

Every stream should be used to the utmost; every river system, from its headwaters in the forest to its mouth on the coast, is a single unit and should be treated as such.^c

A mountain watershed denuded of its forest, with its surface hardened and baked by exposure, will discharge its fallen rain into the streams so quickly that overwhelming floods will descend in wet seasons. In discharging in this torrential way the water carries along great portions of the land itself. Deep gullies are washed in

^a Preliminary Report of the Inland Waterways Commission. Senate Document 325, Sixtieth Congress, first session.

^b Report of the National Conservation Commission. Senate Document 676, Sixtieth Congress, second session.

^c Preliminary Report of the Inland Waterways Commission. Senate Document 325, Sixtieth Congress, first session, page 2.

the fields, and the soil, sand, gravel, and stone are carried down the streams to points where the current slackens. Since the extensive removal of the forest on the upper watersheds there has been a vast accumulation of silt, sand, and gravel in the upper-stream courses. Examples of reservoirs completely filled are already to be seen on almost every stream. In the degree that the forests are damaged on the high watersheds, then inevitable damage results to water power and navigation through increased extremes of high and low water and through vast deposits of gravel, sand, and silt in the stream channels and in any reservoir which may have been constructed.^a

The chief obstacles to navigation, then, are lack of water during portions of the year, and detritus which is washed into the streams and gradually fills the channels or forms obstructions at the mouth. Were the flow uniform, the amount of water carried by a river during the year would be sufficient to provide a good depth at all times. But the flow is uneven; there is too much water at one time and not enough at another. The floods of the spring waste the water which should be available to maintain a navigable depth during the summer and fall. To lessen this inequality of flow should therefore be the aim of all measures for the development of our waterways. If the rivers could be kept always in gentle flood, a relatively small expenditure for reservoirs, locks, and dams would be required. In the same way, if means could be found to prevent silt and sand from being washed into the streams the enormous cost of dredging would be largely done away with. The function of the forest and of the humus beneath as a storage reservoir is of high importance, yet in relation to navigation and the storage of storm waters the influence which the forest has in checking erosion is of equal, if not greater value.^b

In the Southern Appalachians the fullest use of water resources can be secured only by carefully guarding the natural conditions which control them. The valuable water resources of this region depend absolutely upon the maintenance of a protective forest cover. Without this forest cover the water power of the region can never be developed to the full, and in the same way the navigable streams can not be kept from silting up if the forest cover about their headwaters is removed. The protection of these areas is a large undertaking, but it is necessarily the first undertaking, since it is fundamental to the development and utilization of the water resources. If the forest is not first protected, damage to water resources will be far-reaching. If the forest is preserved, the benefits from the standpoint of water utilization will be widely diffused, even far beyond the borders of the Appalachian region.^c

The opinions here quoted represent the almost unanimous view of all who have investigated the relation between mountain forests and navigable rivers. The bill which the committee has reported is in line with the policy of conservation as recommended by the President and the National Conservation Commission. It provides for establishing an adequate programme of protection to the mountain forests by giving the Federal Government the right to cooperate with the States or with private individuals, and by the acquisition of lands where such is necessary. Further, it provides the most natural arrangement for defraying the cost of such acquisition—that of using the funds which come to the Treasury from the national forests already established, and the bill necessitates the appropriation of no additional sums of money in the carrying out of this project.

It has been the policy of the Government to improve its navigable streams by the expenditure of large sums of money, in some cases at their headwaters. For example, a series of reservoirs has been constructed at the headwaters of the Mississippi at a cost of approximately \$2,000,000. Locks and dams have been constructed on the Monongahela River at a cost of \$2,479,818.48; on the Allegheny River, \$1,658,423.18; and on the Ohio River in Pennsylvania, \$5,385,060.78. Expenditures have been made on the headwaters of the Sacramento

^a Report of the Secretary of Agriculture on the Southern Appalachian Watersheds. Senate Document 91, Sixtieth Congress, first session.

^b Report of the U. S. Geological Survey to the Department of Agriculture. Forest Service Circular No. 143.

^c Report of the U. S. Geological Survey to the Department of Agriculture. Forest Service Circular No. 144.

River amounting to \$400,000 for the construction of dams for the purpose of preventing the silting up of the lower channel of the river as a result of hydraulic mining in the mountains.

In France, the first efforts to repair the disastrous torrents were made by engineers along the lower water courses. Dredging and dams, however, proved at best but temporarily effective. Only when they began to push this work up to the headwaters of the streams did they find themselves on the right road.

RELATION OF THE FORESTS TO FLOODS.

Flood damage in the United States has increased from \$45,000,000 in 1900 to \$118,000,000 in 1907. All rivers on whose watersheds the forests have been heavily cut show flood increases. They are greatest in such streams as the Ohio, Cumberland, Wateree, and Santee, where the most timber has been removed, and least in those streams on whose watersheds forest conditions have been least changed. Except in the change of forest conditions there have been no factors that could have intensified flood conditions. In the Ohio River in seventy years the number of floods at Wheeling has increased 62 per cent and their aggregate duration 116 per cent.

In the Cumberland River at Burnside, Ky., the number of floods increased 330 per cent in the fifteen years between 1891 and 1905 and the duration in the same proportion. During the same period in the Wateree River at Camden, S. C., the number of floods increased 65 per cent and the duration 82 per cent. In the Congaree River the increase during the same time has been 94 per cent in number and 113 per cent in duration. In the Savannah River at Augusta, Ga., between the years 1876 and 1905 the increase in the number of floods has been 94 per cent and in duration 266 per cent. Between 1891 and 1905 the Alabama River at Salem, Ala., had an increase in number of floods of 83 per cent and in duration of 31 per cent.

The Geological Survey has made a careful study of floods in the Tennessee River during the past thirty-four years, and has found that on the basis of equal rainfall floods in the last half of the period have increased 18 $\frac{1}{2}$ per cent.

At the Tenth International Congress on Navigation, held in Milan in 1905, engineers from the various countries of Europe were unanimously of the opinion that mountain forests were beneficial in preventing floods, in regulating the low water in streams, and in retaining the soil upon the mountains.

RELATION OF FORESTS TO SOIL WASH.

The annual soil wash in the United States is estimated by the Inland Waterways Commission at about 1,000,000,000 tons, of which the greater part is the most valuable portion of the soil. It is carried into the rivers, where it pollutes the waters, necessitates frequent and costly dredging, and reduces the efficiency of work designed to facilitate navigation and prevent floods. Soil when once lost is replaced with great difficulty, if at all. Consequently the protection of the forests on the slopes which are too steep otherwise to be utilized means actually immense gain in soil conservation.

Not only is soil removed in great quantities from mountain surfaces, but the floods which gather on denuded mountain slopes inevitably result in the destruction of the alluvial soils along the river courses.

OTHER BENEFITS FROM FOREST PRESERVATION.

The protection to navigable streams is the chief purpose of the proposed legislation. Incidentally, there will be great benefits to the whole country in other directions. Water power, like navigation, depends on the regular flow of the streams. The amount of water power capable of development in the United States is sufficient to operate every mill, drive every spindle, propel every train and boat, and light every city, town, and village in the country. The continued successful development of many of our industries in the future depends in large part upon the present protection of our inland waterways. We are using three times as much timber every year as the forest produces, not because we have an insufficient area of forest land, but because our forests are not protected from fire nor properly used. The eastern forests are notable for their hard-wood production, half of the country's supply being obtained from this source. The proposed bill will give protection to the chief hard-wood forests of the country.

EXPERIENCE OF OTHER COUNTRIES PROVES THAT THE PROTECTION OF THE FORESTS AT THE HEADWATERS OF IMPORTANT STREAMS IS IMPERATIVE.

The relation of the mountain forests to the navigability of inland water is the same the world over. Every country that has maintained an even and sufficient flow of streams for the purposes of commerce has had to maintain and in some cases establish upon the headwaters of the streams forests to hold the soil in place and to prevent overwhelming floods.

Germany stands in the forefront of nations in inland waterway development, and she has all of her high mountains protected by forests. These forests have been under government management for a hundred years and they are the most productive and profitable in the world, yielding an average net return of \$2.40 per acre.

The stripping of the forests from the mountains of France was unchecked until 1860, by which time 800,000 acres of farm land had been ruined or seriously damaged and the waterways practically destroyed. The population of 18 departments had been reduced to poverty and forced to emigrate. A futile attempt was then made to check the torrents by sodding. It was only by the acquisition by the Government of the bare lands, the building of stone walls for the gathering of silt and the planting of trees on the soil held in check by those walls that satisfactory results were accomplished. The cost of this method has often been as much as \$50 per acre. By 1900 \$15,000,000 had been spent and the French Government has continued the work by acquiring each year 25,000 to 30,000 acres of land. The present programme calls for the expenditure of \$50,000,000 on this work. About one-fourth of the mountain streams have been brought under control and the balance are beginning to show indications of improvement.

Italy has suffered extremely from the ruin which follows the removal of protective forests. One-third of all the land is unproductive, and though some of this area may be made to support forest growth, one-fourth of it is beyond reclamation, mainly as the result of cleared hillsides and the pasturing of goats. The rivers are dry in summer; in spring they are wild torrents, and the floods, brown with the soil of the hillsides, bury the fertile lowland fields. The hills are scored where the rains have loosened the soil, and landslides have left exposed the sterile rocks, on which no vegetation finds a foothold. Such floods as that of 1897, near Bologna, which did over \$1,000,000 damage, destroy property and life.

The dearth of wood and especially the great need of protecting forests to control stream flow have brought some excellent forest laws. In spite of the first general forest law (1877), which regulated cutting and forbade clearing on mountain slopes, large areas have persistently been cleared, and though provision has been made for thorough reforesting work, very little of the needed planting has been done. The classification of the lands to which restriction shall and shall not apply is a constant matter of dispute. An effort has been made to show that the forest planting contemplated by law is largely unnecessary. The last point, however, has been safely settled by recommendations of a recent commission, which declare that at least 500,000 acres will have to be planted, at a cost of not less than \$12,000,000, before the destructive torrents, brought on by stripping and overgrazing the hillsides, can be controlled.

Spain has suffered greatly from destructive floods caused by insufficient forests on the mountains. She has enacted an elaborate system of laws to prevent overcutting, but the indebtedness of the country has prevented the efficient carrying out of these laws.

Other countries which are working out comprehensive schemes of protecting forests at the headwaters of mountain streams are England in India, Switzerland, Austria-Hungary, Norway, Sweden, Denmark, Russia, Roumania, and Japan.

China holds a unique position as the only great country which has persistently destroyed its forests. What has been done in other countries stands out in bold relief against the background of China, whose mountains and hills have been stripped nearly clean of trees, and whose soil is in many districts completely at the mercy of floods. Trees have been left only where they could not be reached. Streams which formerly were narrow and deep, with an even flow of water throughout the year, are now broad, shallow beds choked with gravel, sand, and rocks from the mountains. During most of the year many of them are entirely dry, but when it rains the muddy torrents come pouring down, bringing destruction to life and all forms of property. In a word, the Chinese, by forest waste, have brought upon themselves two costly calamities—floods and water famine. The forest school just opened at Mukden is the first step in the direction of repairing this waste so far as it now may be repaired.

The results of deforestation in China are particularly discussed and graphically illustrated in the President's annual message to the second session of the Sixtieth Congress.

CONCLUSIONS.

The great increase in floods in our rivers, together with the increasing property loss and annual loss of soils, shows that in some sections of the country we are rapidly approaching the situation in which China now finds herself. It is not now too late for nature to restore the forests on the mountains, but the time is rapidly coming when it will be. The question of protecting the forests at the headwaters of the streams is a national as well as a state problem. It is not right to expect the State to deal entirely with areas requiring protection when those areas affect chiefly other States. It is impossible for States which suffer from conditions outside their own territory to remedy them by their own action. The mountains of the West are already largely under government protection. So far as they are not protected this bill is applicable to them. It is applicable to all other sections of the United States in which the source streams of the navigable rivers lie in nonagricultural, mountainous regions, and it is believed that it will accomplish the necessary protection to the Southern Appalachians and White Mountains.

If the action which this bill proposes is taken by Congress, it will work out to the great benefit of both agriculture and the manufacturing industries, while to the permanent development of our inland waterways the benefits will be fundamental.

KITTREDGE HASKINS.
WILLIAM W. COCKS.
RALPH D. COLE.
ERNEST M. POLLARD.
CLARENCE C. GILHAMS.
JAMES C. McLAUGHLIN.
JOHN W. WEEKS.
JOHN LAMB.
ASBURY F. LEVER.
AUGUSTUS O. STANLEY.
J. THOMAS HEFLIN.

Your committee therefore recommend that all after the enacting clause of Senate bill 4825 be stricken out and the following inserted in lieu thereof:

That the consent of the Congress of the United States is hereby given to each of the several States of the Union to enter into any agreement or compact, not in conflict with any law of the United States, with any other State or States, for the purpose of conserving the forests and the water supply of the States entering into such agreement or compact.

SEC. 2. That the sum of one hundred thousand dollars is hereby appropriated and made available until expended, out of any moneys in the National Treasury not otherwise appropriated, to enable the Secretary of Agriculture to cooperate with any State or group of States, when requested to do so, in the protection from fire of the forested watersheds of navigable streams, and the Secretary of Agriculture is hereby authorized, and on such conditions as he deems wise, to stipulate and agree with any State or group of States to cooperate in the organization and maintenance of a system of fire protection on any private or state forest lands within such State or States and situated upon the watershed of a navigable river: *Provided*, That no such stipulation or agreement shall be made with any State which has not provided by law for a system of forest-fire protection: *Provided further*, That in no case shall the amount expended in any State exceed in any fiscal year the amount appropriated by that State for the same purpose during the same fiscal year.

SEC. 3. That the Secretary of Agriculture, for the further protection of the watersheds of said navigable streams, may, in his discretion, and he is hereby authorized,

on such conditions as he deems wise, to stipulate and agree to administer and protect for a definite term of years any private forest lands situated upon any such watershed whereon lands may be permanently reserved, held, and administered as national forest lands; but such stipulation or agreement shall provide that the owner of such private lands shall cut and remove the timber thereon only under such rules and regulations, to be expressed in the stipulation or agreement, as will provide for the protection of the forest in the aid of navigation: *Provided*, That in no case shall the United States be liable for any damage resulting from fire or any other cause.

SEC. 4. That from the receipts accruing from the sale or disposal of any products or the use of lands or resources from public lands, now or hereafter to be set aside as national forests that have been or may hereafter be turned into the Treasury of the United States and which are not otherwise appropriated, there is hereby appropriated for the fiscal year ending June thirtieth, nineteen hundred and nine, the sum of one million dollars, and for each fiscal year thereafter a sum not to exceed two million dollars for use in the examination, survey, and acquirement of lands located on the headwaters of navigable streams or those which are being or which may be developed for navigable purposes: *Provided*, That the provisions of this section shall expire by limitation on the thirtieth day of June, nineteen hundred and nineteen.

SEC. 5. That a commission, to be known as the National Forest Reservation Commission, consisting of the Secretary of War, the Secretary of the Interior, the Secretary of Agriculture, and one member of the Senate, to be selected by the President of the Senate, and one member of the House of Representatives, to be selected by the Speaker, is hereby created and authorized to consider and pass upon such lands as may be recommended for purchase as provided in section six of this act, and to fix the price or prices at which such lands may be purchased, and no purchases shall be made of any lands until such lands have been duly approved for purchase by said commission: *Provided*, That the members of the commission herein created shall serve as such only during their incumbency in their respective official positions, and any vacancy on the commission shall be filled in the manner as the original appointment.

SEC. 6. That the commission hereby appointed shall, through its president, annually report to Congress, not later than the first Monday in December, the operations and expenditures of the commission, in detail, during the preceding fiscal year.

SEC. 7. That the Secretary of Agriculture is hereby authorized and directed to examine, locate, and recommend for purchase such lands as in his judgment may be necessary to the regulation of the flow of navigable streams, and to report to the National Forest Reservation Commission the results of such examinations: *Provided*, That before any lands are purchased by the National Forest Reservation Commission said lands shall be examined by the Geological Survey and a report made to the Secretary of Agriculture, showing that the control of such lands will promote or protect the navigation of streams on whose watersheds they lie.

SEC. 8. That the Secretary of Agriculture is hereby authorized to purchase, in the name of the United States, such lands as have been approved for purchase by the National Forest Reservation Commission at the price or prices fixed by said commission: *Provided*, That no deed or other instrument of conveyance shall be accepted or approved by the Secretary of Agriculture under this act until the legislature of the State in which the land lies shall have consented to the acquisition of such land by the United States for the purpose of preserving the navigability of navigable streams.

SEC. 9. That the Secretary of Agriculture may do all things necessary to secure the safe title in the United States to the lands to be acquired under this act; but no payment shall be made for any such lands until the title shall be satisfactory to the Attorney-General and shall be vested in the United States.

SEC. 10. That such acquisition may in any case be conditioned upon the exception and reservation to the owner, from whom title passes to the United States, of the minerals and of the merchantable timber, or either or any part of them, within or upon such lands at the date of the conveyance; but in every case such exception and reservation, and the time within which such timber shall be removed, and the rules and regulations under which the cutting and removal of such timber and the mining and removal of such minerals shall be done shall be expressed in the written instrument of conveyance, and thereafter the mining, cutting, and removal of the minerals and timber so excepted and reserved shall be done only under and in obedience to the rules and regulations so expressed.

SEC. 11. That whereas small areas of land chiefly valuable for agriculture may of necessity or by inadvertence be included in tracts acquired under this act, the Secretary of Agriculture may, in his discretion, and he is hereby authorized, upon application or otherwise, to examine and ascertain the location and extent of such areas as in his opinion may be occupied for agricultural purposes without injury to the forests or to stream flow and which are not needed for public purposes, and may

list and describe the same by metes and bounds, or otherwise, and offer them for sale as homesteads at their true value, to be fixed by him, to actual settlers, in tracts not exceeding eighty acres in area, under such joint rules and regulations as the Secretary of Agriculture and the Secretary of the Interior may prescribe; and in case of such sale the jurisdiction over the lands sold shall, ipso facto, revert to the State in which the lands sold lie. And no right, title, interest, or claim in or to any lands acquired under this act, or the waters thereon, or the products, resources, or use thereof after such lands shall have been so acquired, shall be initiated or perfected, except as in this section provided.

SEC. 12. That, subject to the provisions of the last preceding section, the lands acquired under this act shall be permanently reserved, held, and administered as national forest lands under the provisions of section twenty-four of the act approved March third, eighteen hundred and ninety-one (volume twenty-six, Statutes at Large, page eleven hundred and three), and acts supplemental to and amendatory thereof. And the Secretary of Agriculture may from time to time divide the lands acquired under this act into such specific national forests and so designate the same as he may deem best for administrative purposes.

SEC. 13. That the jurisdiction, both civil and criminal, over persons upon the lands acquired under this act shall not be affected or changed by their permanent reservation and administration as national forest lands, except so far as the punishment of offenses against the United States is concerned, the intent and meaning of this section being that the State wherein such land is situated shall not, by reason of such reservation and administration, lose its jurisdiction nor the inhabitants thereof their rights and privileges as citizens or be absolved from their duties as citizens of the State.

SEC. 14. That twenty-five per centum of all moneys received during any fiscal year from each national forest into which the lands acquired under this act may from time to time be divided shall be paid, at the end of such year, by the Secretary of the Treasury to the State in which such national forest is situated, to be expended as the state legislature may prescribe for the benefit of the public schools and public roads of the county or counties in which such national forest is situated: *Provided*, That when any national forest is in more than one State or county the distributive share to each from the proceeds of such forest shall be proportional to its area therein: *Provided further*, That there shall not be paid to any State for any county an amount equal to more than forty per centum of the total income of such county from all other sources.

SEC. 15. That a sum sufficient to pay the necessary expenses of the commission and its members, not to exceed an annual expenditure of twenty-five thousand dollars, is hereby appropriated out of any money in the Treasury not otherwise appropriated. Said appropriation shall be immediately available and shall be paid out on the audit and order of the president of the said commission; which audit and order shall be conclusive and binding upon all departments as to the correctness of the accounts of said commission.

Amend the title so as to read: "An act to enable any State to co-operate with any other State or States, or with the United States, for the protection of the watersheds of navigable streams, and to appoint a commission for the acquisition of lands for the purpose of conserving the navigability of navigable rivers."

VIEWS OF THE MINORITY.

In the first session of the Sixtieth Congress, reporting upon a resolution offered by Mr. Bartlett, of Georgia, the Committee on the Judiciary of the House of Representatives declared it to be their opinion that—

The Federal Government has no power to acquire lands within a State solely for forest reserves, but under its constitutional power over navigation the Federal Government may appropriate for the purchase of lands and forest reserves in a State, provided it is made clearly to appear that such lands and forest reserves have a direct and substantial connection with the conservation and improvement of the navigability of a river actually navigable in whole or in part.

Bearing that opinion in mind (and it has met with universal acquiescence), it becomes of the very first importance, in considering a bill for the purchase of forest reserves, to determine whether such reserves "have a direct and substantial connection with the conservation and improvement of the navigability of a river actually navigable in whole or in part." The statement that such connection does exist has been so confidently assumed and so often repeated that those who have given but a casual or superficial study to the subject have come to regard it as an established and admitted fact.

The truth is that it is neither established nor admitted. On the contrary, the proposition is very earnestly disputed by men whose opinions are entitled to great weight. It is perhaps not overstating it to say that a majority of the riparian engineers who have given the subject careful study are of the opinion that forests do not exercise any effective control in either extremes of high water or of low water. Lieut. Col. H. M. Chittenden, of the United States Army Engineer Corps, who has been studying the control of floods in rivers for many years, is perhaps the most conspicuous exponent of this view in our own country, having recently read a paper before the American Society of Engineers in which is presented a powerful and to many minds a convincing argument in support of his contention. In Europe the same opinion is entertained by M. Ernst Lauda, chief of the hydrographic bureau of the Austrian Government, who has recently made an exhaustive report upon the great floods of the Danube, in the course of which he says:

It is universally believed that forests have an influence in moderating and preventing floods, and deforestation upon their origin and more frequent occurrence, yet this belief is not better established from a hydrographic standpoint than the entirely unfounded belief that the floods of the past few years in Austria are due to deforestation. Against the popular belief in the favorable influence of forests upon floods resulting from excessive rains may be adduced the interesting fact that lands richest in forests are frequently visited by the severest floods.

In support of this opinion he traces the history of the Danube River for eight hundred years, drawing the conclusion that floods were formerly just as frequent and just as high in that river as they have been in recent times. He cites the records of the river Seine also showing

even greater flood height in the sixteenth century than any that occurred in the nineteenth. As deforestation in the watersheds in both the Danube and the Seine is vastly greater now than it was eight centuries or three centuries ago, the testimony of the actual records presented by M. Lauda can not be lightly set aside. Nor can it be said that M. Lauda stands alone in his opinion, for at the Tenth International Congress of Navigation, held at Milan in 1905, papers upon this subject were presented by representatives from France, Germany, Italy, Austria, and Russia, and while all the writers favored forest culture the opinion was practically unanimous that forests exert no appreciable influence upon the stream flow of rivers.

Indeed, Colonel Chittenden, who has perhaps studied foreign reports upon this subject more carefully than any other American, declares that he is unable to find among the river engineers of Europe any that advocate forests as a corrective for the extremes of flow in our rivers. He cites an exceedingly elaborate investigation instituted by Napoleon III, as a result of which the French engineers, after an exhaustive study of the subject, united in the opinion that whatever value forests might have locally in preventing the erosion of steep slopes they could not be relied upon in any degree to diminish the great floods from which France had been suffering, and that any measures which might be taken in the line of reforestation would have no appreciable effect. The report of these engineers quoted a very elaborate and exhaustive work upon the floods of French rivers, going back over six hundred years, in which it was conclusively shown that former floods were larger than those of the present time. As a result of this report it is declared that no French project of river improvement, either for flood prevention or as an insurance against low water in navigable rivers, has embraced reforestation as an essential part or even any part at all.

In our own country, where river records have been kept but a comparatively short time, the data are of course insufficient to warrant any very sweeping generalizations. We believe it is admitted, however, that the records of the Ohio River, which extend over a period of forty years, show greater extremes of both high water and low water during the first twenty years of that period than during the last twenty years, thus bearing out in a degree at least the conclusions reached through a study of the extended periods of observation of European rivers. While it can not be regarded, therefore, as fully established, we submit that the weight of expert testimony and the preponderance of evidence as deduced from actual observation is very largely in favor of the proposition that forests do not exercise an appreciable influence upon the navigability of navigable rivers.

But the argument against the proposition in the bill under consideration by no means rests alone upon the contention that there is no vital connection between the forests and the maintenance of navigability in navigable streams. It is a conceded fact that at the present time, in the southern Appalachians at least, the menace to the streams comes from the operations of the farmer and not from those of the lumberman. It is the tracts on the lower slopes of the mountains which have been cleared for farming from which the silt is washed into the streams and not from the upper slopes, which are covered with trees. Now, it is not denied that if these lower slopes are properly farmed the soil will not wash appreciably, and the streams therefore will receive no damage. It is not denied either that if the steeper

slopes, which never can be farmed, are protected from fire they will always be forested, or at least covered with a growth that will prevent erosion.

Remembering these two undenied facts, can it be argued that it is necessary for the Government to purchase either the upper or the lower slopes of the mountains in order to protect the streams? The lower slopes are more valuable for farming than for timber raising if they can be prevented from erosion. Since they can be so prevented by proper methods of tillage, would it not be better national economy for the Federal Government to help teach the farmers of that region how to till their soil in such a way as to prevent erosion and maintain its fertility than it would be to buy out those farmers and return the land to the wilderness? And since the upper slopes will always have a forest cover, if protected from fire, would it not be better national economy for the Federal Government to lend its aid to such protection at a comparatively trifling cost (it is estimated by the Forest Service that the cost of an effective fire patrol would not exceed 2 cents per acre per annum) than to buy the land at a very great initial expenditure, with the cost of fire protection to be added as a fixed and continuing charge? Would it not be better for the States concerned to have the lands remain in private ownership, supporting a larger population than could possibly be maintained if the policy of the pending bill is pursued, and retaining the value of the property on the tax rolls?

The very best that can be said in support of the proposition for the federal purchase of these lands is that as a result of such purchase the impairment of navigable streams may possibly be diminished or retarded. But will this vague general possibility, or probability, of a distant and shadowy good offset the immediate and certain evil of driving large numbers of people away from homes which in many instances have been occupied for generations, of reducing the productivity of large areas, and of taking large amounts of property from local tax rolls?

It is cited as a special merit in the pending bill that the money to carry it into effect is taken not from the General Treasury but from the receipts of the existing Forest Service, the agreeable inference therefrom being that the proposed new forests can be bought without any real draft upon the Treasury. We are unable to see the force of this argument. The receipts from the present national forests are not a new source of income conjured into existence by the pending bill. On the contrary, these receipts are a part of the national revenues which are paid into the Federal Treasury, just as are the revenues from customs dues or internal taxation. To regard the income from the forests as a special fund which can be diverted without any real effect upon the Treasury balances is a palpable fiction, which if adopted would expose the Congress to the charge of doing by indirection what it was not willing to do directly. If we are going to enter upon this policy, let us do it openly and boldly with a full understanding of what it will cost and where the money is to come from.

In its terms, the life of the measure being limited to ten years and the expenditures under it restricted in the aggregate to \$19,000,000, this bill is extremely conservative compared with others that have been introduced upon the same subject. It is to be noted, however, that it is applicable to every section of the country, and that the foremost ad-

vocates of the policy which it initiates maintain that the policy can only be carried to a successful issue through the purchase of many million acres of land. The last official report upon the subject recommended the purchase of 5,000,000 acres in the southern Appalachians and 600,000 acres in the White Mountains, the average estimated cost being \$3.50 an acre. But it states also (on page 32) that there are 75,000,000 acres in these mountains which "will have to be given protection before the hard-wood supply is on a safe footing and before the watersheds of the important streams are adequately safeguarded." While no one now advocates the purchase of this enormous area, yet with the policy once entered upon and backed by the tremendous political and industrial influences that can be brought to its support, who can give assurance that such purchases may not be made in the future and the cost of this policy be thereby extended from tens of millions to hundreds of millions?

Notwithstanding the enormous expenditure which will almost inevitably result from the entrance upon this policy, it might still be warranted if it were a demonstrated fact that the maintenance of the forested watersheds is the only way by which the filling up of navigable streams and the destructive erosion of large sections of our country can be prevented, and that the only means by which forested watersheds can be maintained is through federal ownership of such watersheds. Believing, however, that this destructive erosion and consequent silting of rivers can be prevented by the introduction of proper methods of farming and by adequate fire protection, both of which can be accomplished through the cooperation of state and federal agencies at comparatively little expense, we are unwilling to consent to a measure which commits the Government to a policy which we believe to be both unwise and unnecessary.

CHAS. F. SCOTT.
WM. LORIMER.
GEO. W. COOK.
JACK BEALL.
W. W. RUCKER.

VIEWS OF MR. HAWLEY.

In addition to joining in the dissent of the minority and commending its vigorous presentation of the matter, I desire to add the following observations:

This bill provides for the acquisition of lands anywhere in the United States for the establishment of new forest reserves or national forests. These lands are to be acquired from the present private owners upon the recommendation of a commission, as provided in the bill. It is stated that the purpose of such acquisitions is to preserve and improve the navigability of navigable rivers, apparently following the opinion of the Committee on the Judiciary of the House, as expressed in House Report No. 1514 of this Congress. It is inferred that if the policy proposed in the bill is carried out, under the terms and by the means therein set forth, that in due time extremes of high and low water in navigable rivers will be regulated, and the hindrance to navigation due to the deposit of silt will be controlled. The vital question at this point is, "Will this be the result?" If not, then the theory on which the bill is based fails, and its justification also fails, under report No. 1514, referred to above. Upon this relation between the proposed control and navigation or stream flow the authorities disagree, as set forth at length in the preceding opinion of the minority. And no agreement exists as to where the necessary lands lie or as to what is their nature.

The bill also provides that for the same purposes the Government may administer private forest lands adjacent to the lands in the proposed new reserves, for a term of years, upon agreement with the owners. There is little evidence to show whether few or many owners of forest lands will so agree, and in my judgment not many will accept the terms proposed. If they do not, the amount of land necessary to be acquired by the National Government in order to carry out the policy in the bill will be increased and add largely to the appropriations required.

It is proposed to appropriate from the revenues of existing forest reserves \$1,000,000 for the first year, and \$2,000,000 annually thereafter for a period of nine years, in all \$19,000,000. In view of the large areas it is proposed to control, this amount must be regarded rather as an experimental appropriation than as a sum adequate to accomplish the purposes of the bill. The report of the Secretary of Agriculture, made in compliance with the provision in the agricultural appropriation bill, approved March 4, 1907, which directed him to make an investigation of this question (see S. Doc. 91, 60th Cong., 1st sess.), on pages 30, 31, and 32, says:

AREA AND LOCATION OF LANDS NEEDING PROTECTION.

In order to determine the extent of the lands primarily available for forests in the Southern Appalachian and White Mountain regions, a reconnaissance survey has been made, as a result of which the accompanying maps have been prepared. Maps I and II show for the two regions the lands to be classed as distinctly mountainous and nonagricultural.

The main centers for such mountainous and nonagricultural lands in the Southern Appalachians are, first, the Blue Ridge and Great Smoky Mountains of North Carolina and Tennessee, South Carolina and Georgia; second, the Allegheny Mountains of eastern and southern West Virginia and western Virginia, and, third, the Cumberland Mountains of eastern Kentucky, Tennessee, and northern Alabama. These lands include the main mountain ranges, and the roughest, wildest land of the region. Naturally, they embrace a smaller proportion of agricultural lands than other parts of the region, and those which they do embrace have for the most part been eliminated, as will be seen from the irregular boundaries on the map. Regardless of these eliminations they still include some small bodies of agricultural lands.

These areas, though they contain only 40 per cent of the timbered land of the Southern Appalachians, include almost all of the virgin timber lands, because the virgin timber which remains is mostly situated on the high mountains. Even though these lands do produce an inferior grade of timber, their sole use must be for timber production. There is no other crop which will hold the gravelly, stony soil in place and keep it from clogging the channels of streams and covering the agricultural valleys which lie below. These nonagricultural and mountainous lands, approximating 23,000,000 acres, give rise to all the important streams which have their source in the Southern Appalachians. They are therefore the vital portions of these mountains. Whatever work is done to protect the Southern Appalachians must center in these areas. The proportion to which these lands fall into different States and watersheds is shown in the following tables:

TABLE 4.—*Area, by States, of nonagricultural and mountainous lands in the Southern Appalachians.*

State.	Area.	State.	Area.
Tennessee	4,962,000	West Virginia	5,797,000
Virginia	3,882,000	South Carolina	590,000
Alabama	491,000	Maryland	277,000
Georgia	1,806,000	Total.....	23,310,000
Kentucky	1,623,000		
North Carolina	3,882,000		

TABLE 5.—*Area, by watersheds, of nonagricultural and mountainous lands in the Southern Appalachians.*

Watershed.	Area.	Watershed.	Area.
Tennessee	2,489,000	Yadkin	428,000
Cumberland.....	2,759,000	Big Pigeon	20,000
Holston	582,000	Catawba	502,000
James	1,138,000	Broad	299,000
Roanoke (Staunton)	431,000	Potomac	2,095,000
New (Kanawha)	3,225,000	Chattahoochee	345,000
Big Sandy	1,347,000	Little Pigeon	19,000
Hiwassee.....	1,066,000	Twelve Pole	1,000
Little Tennessee.....	1,307,000	Savannah	860,000
French Broad	623,000	Guyandotte	660,000
Pigeon	255,000	Saluda	100,000
Little River.....	202,000	Kentucky	156,000
Monongahela	987,000	Coosa	767,000
Nolichucky	379,000	Total.....	23,310,000
Youghiogheny	117,000		
Rapidan.....	151,000		

While the lands shown on the map are all in need of protection, they are not all of equal importance when all economic points of view are considered.

The lands to be classed as of first importance include the mountain ridges mainly, but extend considerable distances down the slopes in those localities where the soil is particularly subject to erosion and on the watersheds of streams of greatest importance for water power or navigation. The area of such lands does not exceed 5,000,000 acres.

The same class of land for the White Mountain region is shown in Map II. It lies in both New Hampshire and Maine. Excluding the numerous bodies of water, their area in New Hampshire is 1,457,000 acres, and in Maine 700,000 acres, mak-

ing a total of 2,157,000 acres. The proportion in which this falls in the five water systems included is as follows:

	Acres.
Connecticut	429,000
Merrimac	264,000
Saco	332,000
Androscoggin	1,002,000
Kennebec	130,000
Total	2,157,000

There is also shown on this map an area embracing only the four main ranges of the White Mountains. A few thousand acres of this area lie in Maine. All the rest is in New Hampshire. This principal White Mountain area covers 668,000 acres, and, considering all economic points of view, is the most important part of the region.

TREATMENT OF THE REGION.

The areas indicated in the preceding section, 23,310,000 acres in the Southern Appalachians and 2,157,000 acres in the White Mountains, do not include all the mountainous timber lands of the Appalachians. As is discussed under the heading "Importance of Appalachian forests for hard-wood supply," there are probably 75,000,000 acres in this mountain system more important for timber production than for any other purpose. This area will have to be given protection before the hard-wood supply is on a safe footing and before the watersheds of the important streams are adequately safeguarded.

If it is a wise policy for the Government to control by purchase or agreement with owners such large areas of land, and in addition thereto extensive areas included in this bill, but not included in the report of the Secretary of Agriculture, then it should be undertaken on a scale commensurate with its proposed final extent, and for which appropriations many times the present amount will be required.

This bill if enacted into law will inaugurate a system of new forest reserves whose final limits will include the lands the administration of which by the National Government may be said to conserve and regulate stream flow and assist in maintaining the navigability of navigable rivers. In my opinion the proposed appropriation of \$19,000,000 is sufficient only to make a beginning and to commit the Government to the policy. It initiates one of the most extensive and momentous movements ever begun in this country by legislative action. It seems to me there of necessity should be required prior thereto an exceedingly thoroughgoing and exhaustive investigation by competent authority of all the problems involved, for the information of the country and of Congress, and if thereafter the proposed policy is considered wise and within the powers of Congress, a measure should be prepared that will present the matter in all its magnificence to the country and provide adequate appropriations for executing the policy, and granting all necessary authority therefor.

Does the present bill authorize the commission to use the power of eminent domain to obtain from unwilling owners the lands deemed necessary? If not, is not the omission of such authority an error?

I fear, also, that when the Government goes into the market to purchase from private parties the lands for the new forest reserves great difficulties will be encountered, arising out of speculations in these lands.

The committee have held many hearings on this subject, the net result of which discloses the lack of accurate and adequate data. For the purpose of securing carefully collected and scientifically presented

information on all phases of the subject, I introduced a bill at the last session, and the fact that the information called for by it is not available seems to justify the printing of it as an appendix.

Truly yours,

W. C. HAWLEY.

[H. R. 21877. Sixtieth Congress, first session.]

A BILL To provide for obtaining certain information relative to the White Mountain, Appalachian, and other watersheds and forests.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That a commission consisting of three men, whose duties are defined below, shall be appointed as follows: One by the President of the United States, one by the President of the Senate, and one by the Speaker of the House of Representatives.

SEC. 2. That the duties of this commission shall be as follows:

First. Personally to visit every watershed in the States named in section seven of this act supposed to have influence in regulating the flow of waters and conservation of water supply in the maintenance of the navigability of navigable rivers, and for other purposes.

Second. To establish by metes and bounds the limits of such watersheds and to actually ascertain the areas included.

Third. To ascertain how much of such areas are now forested and the kinds and sizes of the trees and other growths thereon.

Fourth. The general nature and character of the soil of these watersheds and the general topography of said watersheds.

Fifth. To ascertain how much of such areas are now deforested and the condition of the deforested lands.

Sixth. To ascertain what portions of the deforested areas can be reforested, how much can not be reforested, and the probable cost and period of time required for reforestation of such areas.

Seventh. To ascertain whether these watersheds have a definite and demonstrable physical connection, mediate or immediate, with the maintenance and improvement of the navigability of navigable rivers.

Eighth. To ascertain as accurately as possible the value of the lands of each watershed and the price at which they can be acquired.

Ninth. To ascertain whether any of these watershed areas will be transferred to the United States, either as a gift or to be placed under the control of the United States, and if so, for what length of time.

Tenth. If the question implied in paragraph seven is decided affirmatively, to ascertain whether the control of the watershed areas will be sufficient for the conservation and improvement of the navigability of navigable rivers, or whether the control of areas below and other than the watershed areas will be necessary for that purpose. If areas other than watershed areas are decided to be necessary, then such areas shall be definitely located and measured, and their values and the prices for which they can be bought shall be ascertained.

Eleventh. To ascertain the annual precipitation on each watershed area as nearly as possible and for as long a period of years preceding as possible.

Twelfth. To estimate the probable annual revenues, if any, from such watershed and other areas and the cost of administration yearly if acquired by the Government.

Thirteenth. To ascertain the miles on each river supposed to be directly or indirectly benefited that are now navigable, and the number of months each such river is navigable, the depth of water for each month, and the draft of vessels using same.

Fourteenth. To ascertain the increase or diminution of the miles of navigable water in each such river and the depths of water therein for the longest period of years possible.

Fifteenth. To ascertain the amount of commerce carried, by months, on each such river for the longest period of years possible.

Sixteenth. To ascertain the effects of erosion due to the denudation of watershed or other areas and the damage effected thereby.

Seventeenth. To ascertain what effect on high and low water in rivers the drainage and tiling of farm land has had.

Eighteenth. To ascertain who are the present owners of the areas referred to in this act and when they obtained such lands.

Nineteenth. To ascertain whether large tracts have been recently acquired and whether options have been taken on the lands, and if so, in what quantities.

Twentieth. To ascertain the amount of timber cut on the watersheds aforesaid yearly and the rate of such cutting for a period of years as long as possible.

Twenty-first. To ascertain the facts in the development of water power in such areas.

SEC. 3. That the said commission shall have authority to employ expert and unskilled labor necessary to enable them to perform the duties imposed upon them and to fix compensation therefor.

SEC. 4. That each of said three commissioners shall be paid at the rate of five hundred dollars per month and shall receive compensation for necessary personal expenses incurred in the discharge of their duties.

SEC. 5. That there is hereby appropriated, out of any money in the Treasury not otherwise appropriated, the sum of thirty thousand dollars to provide payment for services and expenses authorized by this act.

SEC. 6. That said commission shall report completely, finally, and in full on or before February first, nineteen hundred and nine.

SEC. 7. That the watersheds and other areas described in this act, and which the commission herein provided shall investigate under the provisions of this act, are those located in the following States: Maine, New Hampshire, Vermont, New York, Pennsylvania, Ohio, Kentucky, Tennessee, West Virginia, Virginia, Maryland, North Carolina, South Carolina, Georgia, and Alabama.

VIEWS OF MR. HAUGEN.

Before entering upon such a gigantic scheme as is contemplated in the proposed bill, one which in the end in all probabilities will involve the expenditure of not millions but billions of dollars, Congress should have detailed and accurate information in order that the matter might be carefully, fully, and intelligently considered. It should at least have data, or reliable estimates, as to the probable cost, the number of acres that should be purchased for the preservation of the forests within the watersheds of the navigable rivers not only in the White Mountains and the Southern Appalachian Mountains, but over the whole country. The only official information available at the present time is that obtained under the act of Congress of March 4, 1907, which "requires the Secretary of Agriculture to investigate the watersheds of the Southern Appalachian and White Mountains and to report to Congress the area and natural conditions of said watersheds, the price at which the same can be purchased by the Government, and the advisability of the Government purchasing and setting apart the same as national forest reserves for the purpose of conserving and regulating the water supply and flow of said streams in the interest of agriculture, water power, and navigation."

In this report the Secretary recommends that the Government acquire an area of about 6,000,000 acres at once, and states that an area of about 75,000,000 acres will have to be given protection. The Secretary has this to say (p. 32):

It is an enormous undertaking to bring this immense area of 75,000,000 acres under proper conditions of protection and use. If the Government owned the land the problem would be a comparatively simple one under our present forest policy.

I conclude from this that it is necessary to purchase the 75,000,000 acres to begin with. As to the method of acquirement and cost of lands the Secretary has this to say:

WHITE MOUNTAINS.

The timber lands of the White Mountains are in the main held by a few large companies, nearly all of whom are cutting extensively on the spruce stands for pulp or lumber manufacture. The plants of some of these companies represent an investment of several hundred thousand dollars. Manifestly, in negotiating for these lands, in so far as they bear uncut timber, the value of the plant must enter into the consideration. In addition, the stumpage value of spruce ranges from \$4.50 to \$6 or \$7 per thousand. This would give the best stands a value of \$75 to \$125 or more per acre.

* * * * *

The hard woods of the White Mountains, of which there is a large area, have not the value of spruce, nor are they as yet being extensively cut. Their stumpage value is from \$2.50 to \$4 per thousand, depending upon location, stand, and quality.

The cut-over lands have a value ranging from \$1 to \$6 or \$8 per acre, depending upon the condition of the timber growth upon them.

The question of the acquirement of timber lands by the Government has been considered with the principal owners of the region. While unwilling to dispose of their

virgin timber lands, except at very high prices, they are willing to consider the sale of their cut-over lands, the lands lying too high for lumbering, and the mountain tops.

A careful study of the situation leads to the conclusion that most of the lands of these classes can be bought at an average price of \$6 per acre.

SOUTHERN APPALACHIAN MOUNTAINS.

In the Southern Appalachians the timber lands are owned by large companies to a less extent than in the White Mountains, but even here as much as 50 per cent of many localities is under such ownership.

Timber-land owners in the Southern Appalachians are generally inclined to sell their lands to the Government at a reasonable price, regardless of whether the lands contain virgin timber or are cut over. Furthermore many of them are favorable to the transfer of their lands, themselves retaining the right to cut and remove certain kinds of timber above specified sizes.

In considering the practicability of the Government's purchasing land for national forests in the Southern Appalachians conference has been freely had with timber-land owners, lumbermen, real estate dealers, and title examiners. Moreover, attention has been paid to the sales which have been made during the past two years and the prices which have been paid.

The price of virgin hard-wood land varies from \$5 to \$12 per acre, depending on accessibility and kind and quality of timber. Cut-over lands are worth from \$2 to \$5 per acre, their value likewise depending upon their location and the condition of the timber growth upon them.

From this report, or any other information available, who can figure out the probable outlay of money? No data is furnished as to the number of acres of the \$75 and \$125 per acre land. There is no data as to the number of plants. All that is known is that some of these lands are valued at from \$75 to \$125 per acre, and that there are plants there representing an investment of several hundred thousand dollars, and that the value of the plants must enter into the consideration. No data is given as to the number of acres of hard wood, except that there is a large area. No data is given as to the number of acres of cut-over land, valued at from \$1 to \$8 per acre, except that it is believed that most of the land of these classes can be bought at an average price of \$6 per acre.

Suppose the average price of all the 75,000,000 acres to be purchased in this region is \$20 per acre, it would mean an investment of one and one-half billion dollars, an amount more than six times the cost of the building of the Panama Canal, or nearly twice the amount of our present interest-bearing debt, or four times the value of the total annual products of the Iowa farms.

The Secretary reports that these timber lands are in the main held by a few large companies. This means large prices. Besides, the Government generally pays more for what it buys and will have to pay larger prices than would have to be paid by individuals in purchasing the same lands.

The Secretary reports that the principal owners of lands are unwilling to dispose of their virgin timber lands, except at a very high price; that the cut-over lands, lands lying too high for lumbering, and the mountain tops, or, in other words, that only such lands as are not needed or desired for this or any other purpose are offered for sale.

Considering the Secretary's report and the fact that the purchase of the 75,000,000 acres, involving an expenditure of probably over a billion dollars, is probably only a small part of the land necessary to be acquired, as undoubtedly enterprising and patriotic real estate owners in other parts of the country would be willing to unload their

lands onto the Government, especially when the price is to be very high, and will insist that there be an equitable distribution of these billions of dollars; and considering also the enormity of the whole proposition, is it not the part of wisdom, common sense, and sound business judgment first to obtain detailed, accurate, and reliable information in order that a comprehensive, well-devised, and practical policy may be worked out and followed?

Considering also that the proposed bill is an entering wedge to such a gigantic proposition, I feel constrained to dissent from the views of the majority, and believe that for the present that H. R. 21986, passed the first session of this Congress, is the proper legislation. Its provisions are clearly set forth in Report No. 1700, a copy of which is appended.

GILBERT N. HAUGEN.

[House Report No. 1700, Sixtieth Congress, first session.]

The Committee on Agriculture, to which was referred House bill 21986, has had the same under consideration and reports as follows:

At the beginning of the present session a number of bills were introduced and referred to the Committee on Agriculture having for their general purpose the purchase of certain tracts of land in the White Mountains and in the Southern Appalachian Mountains with a view to preserving the forests on said lands and conserving the flow in the rivers having their sources therein. The committee considered its most pressing duty to be, first, to prepare the appropriation bill for the Department of Agriculture. Before the consideration of this bill had been completed a resolution was introduced by Representative Bartlett, of Georgia, providing that the bills above mentioned, commonly known as the White Mountain and Appalachian Park forest-reserve bills, be referred to the Committee on the Judiciary with the request that that committee render an opinion as to the constitutionality of the proposed measures. This resolution was adopted by the House, and the bills were referred accordingly. Pending the report of the Committee on the Judiciary the Committee on Agriculture was of the opinion that it could not properly give consideration to these measures.

On April 20, 1908, the Committee on the Judiciary rendered an opinion to the effect that the United States would have no right to purchase lands for the purpose of creating a forest reserve, but that Congress might appropriate for the purchase of lands having a direct and substantial connection with the navigability of navigable rivers. As a result of this decision, Representatives who had introduced the bills which had been referred to the Committee on the Judiciary modified and reintroduced them, and they were again referred to the Committee on Agriculture, which took up the consideration of them at the earliest possible date. After hearing testimony and considering the bills for several days it became evident that the committee, with the information then before it, was unwilling to favorably recommend any measure committing the United States to the policy of purchasing forest lands. The whole matter was therefore referred to a subcommittee, with instructions to recommend to the full committee such action as it was deemed proper to take. As a result of the deliberations of this subcommittee, the bill, H. R. 21986, was reported to the full committee, and by its action is herewith reported to the House.

It is a matter of common knowledge that the forests in the White Mountains and in the southern Appalachian Mountains are being rapidly destroyed, and the desirability of preserving what remains of them, or at least of introducing methods of lumbering which will prevent the destruction of immature timber and will protect the forests from fire, is universally conceded, not only for the perpetuation of the timber supply, but also for the conservation of the flow of water in the streams having their source within these forests. The problem as to how this desired end should be reached has been widely discussed and has awakened profound interest throughout the entire country. As a result of this discussion four distinct methods have been suggested.

First. It has been held by many that the problem was one belonging exclusively to the States concerned. Those holding this view have argued that the Federal Government has no constitutional authority to purchase lands for the purpose of conserving the forests upon them, even though such preservation may conserve the

supply of water in navigable streams. They hold that the matter is one over which the States have exclusive jurisdiction, and that if the right exists it is the duty of the State to assume the responsibility of meeting it.

Second. Another view is that while it is neither the right nor the duty of the Federal Government to purchase the forests it may properly cooperate with the States or with private owners in their preservation by furnishing expert advice and assistance in their proper utilization and administration.

Third. Still another view is that when it is shown that the forests of a given watershed have a direct and substantial connection with the navigability of the navigable rivers flowing from that watershed the Federal Government has the right to exercise jurisdiction over the forests therein, although they remain in private ownership, and prescribe the method which shall be followed in utilizing the forests within such watershed.

Fourth. The last, and doubtless the most generally advocated plan, proposes that the Federal Government shall buy all the land that may be necessary to protect the watersheds of navigable rivers and exercise over the forests growing upon them all the rights and privileges of absolute ownership.

The bill now before the House was drawn with a view to meeting, in a measure at least, each of these four proposed plans. The first section proposes to give the consent of Congress to each of the several States of the Union which may wish to do so to enter into such agreement or compact, not in conflict with any law of the United States, as it may deem desirable or necessary, with any other State or States for the purpose of conserving the forests and the water supply of the States entering into such agreement or compact. It has been often urged, by those who insist that the Federal Government should purchase the forests under consideration, that the problem is interstate, and in view of the constitutional inhibition against a State entering into any agreement or compact with another the proper treatment of the problem is made impossible to the States alone. If section 1 of this bill becomes a law this obstacle to cooperation between and among the States will be removed.

Section 2 of the bill appropriates the sum of \$100,000 to enable the Secretary of Agriculture to cooperate with any State or group of States, when requested to do so, by supplying expert advice on forest preservation, utilization, and administration, and upon reforestation of denuded areas. It also authorizes the Secretary of Agriculture to enter into agreement with the owners of any private forest lands situated upon the watershed of a navigable river, to administer and protect such forest land upon such terms as the Secretary of Agriculture may prescribe. It is believed that under the authority given in this section many thousands of acres of forest lands will be brought as effectually within the jurisdiction of the United States for all the purposes of scientific forestry as if these lands were actually owned by the Government.

Section 3 of the bill provides for the appointment of a commission to be composed of five Members of the Senate, to be appointed by the presiding officer thereof, and five Members of the House of Representatives, to be appointed by the Speaker.

Section 4 makes it the duty of this commission to investigate all questions tending to show the direct and substantial connection, if any, between the preservation of the forests within the watersheds of the navigable rivers having their sources in the White Mountains and Southern Appalachian Mountains, and the navigability of said rivers. And in case the commission shall determine that such direct and substantial connection exists, it shall then be its duty to ascertain to what extent, if at all, it may be necessary for the Government of the United States to acquire land within the watersheds referred to, the number of acres of such land, and the probable cost, or whether it may be desirable, if within the power of the United States to exercise, without purchase, such supervision over such watersheds as may be necessary to conserve the navigability of the rivers proceeding therefrom.

Under the provisions of this section all the questions arising out of the proposal that the Federal Government purchase the forests or that it exercise jurisdiction over them without purchase, may be carefully studied and fully considered. It is true that by an act of the last Congress the Secretary of Agriculture was authorized to report and did report upon the watersheds of the Southern Appalachian and White mountains, the purpose of the report being to present to Congress "the area and natural conditions of said watersheds, the price at which the same can be purchased by the Federal Government, and the advisability of the Government purchasing and setting aside the same as national forest reserves for the purpose of conserving and regulating the water supply and the flow of said streams in the interest of agriculture, water power, and navigation."

Without intending any reflection upon those who prepared this report, it may be fairly said that it does not present such detailed and accurate information as any careful business man would insist upon having before entering upon a policy which

was to involve the expenditure of many millions of dollars. It does not indicate the extent of the navigable portions of the rivers whose navigability it is desired to protect nor the value of the forests upon them. It presents no data showing to what extent, if at all, the volume or the steadiness of stream flow has been influenced by the destruction of the forests. It shows in only the most general way the location, area, and probable cost of the lands it is proposed to purchase.

While it recommends (p. 37) that the Government acquire an area of 600,000 acres in the White Mountains and 5,000,000 acres in the southern Appalachian Mountains, it states also (p. 32) that an area of 75,000,000 acres will have to be given protection "before the watersheds and important streams are adequately safeguarded," suggesting the thought that while less than 7,000,000 acres are to be purchased at once, 75,000,000 acres must ultimately be acquired if the watersheds of the important streams are to be "adequately safeguarded." Your committee is of the opinion that if a commission of ten members of the legislative body, responsible to their constituents and to the country for whatever report they may make, is directed to investigate the subject, the information presented in its report will be sufficiently comprehensive and exact to enable Congress to intelligently legislate upon the subject. The commission is given authority to employ experts and such clerical assistants as may be needed, and is required to report to the President not later than January 1, 1909.

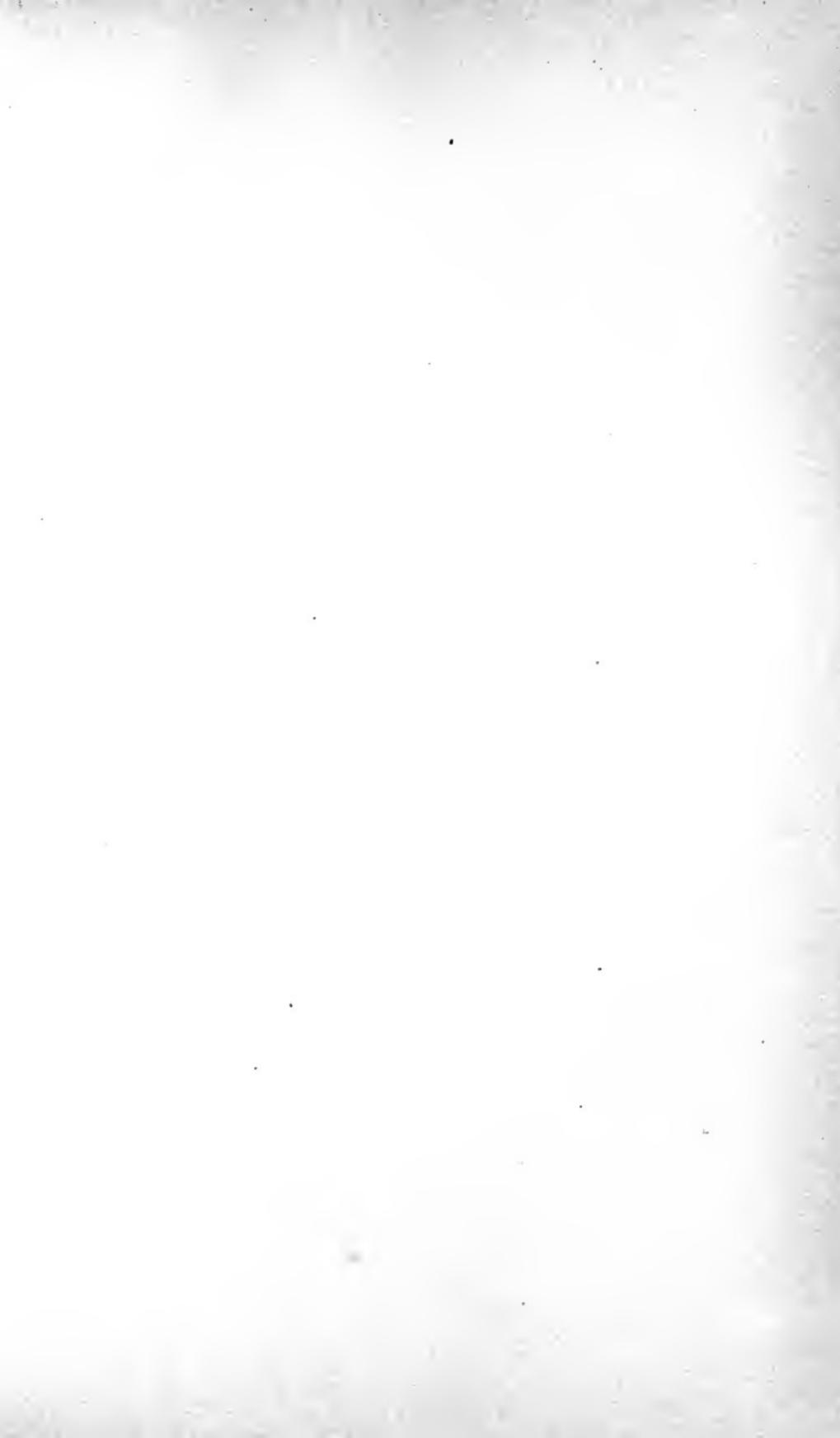
Believing that this bill, by opening the way for the States to cooperate with one another, puts it within their power to contribute much to the solution of this important problem; that the provision it makes for cooperation between the United States, the States, and private owners of forest lands must contribute greatly to the rapid extension of scientific forestry; and that by means of the commission for which it provides the most careful study of the whole problem with a view to future legislation is made possible, and that for these reasons the proposed legislation will be of great public advantage, your committee respectfully reports the bill back to the House with the recommendation that it do pass.

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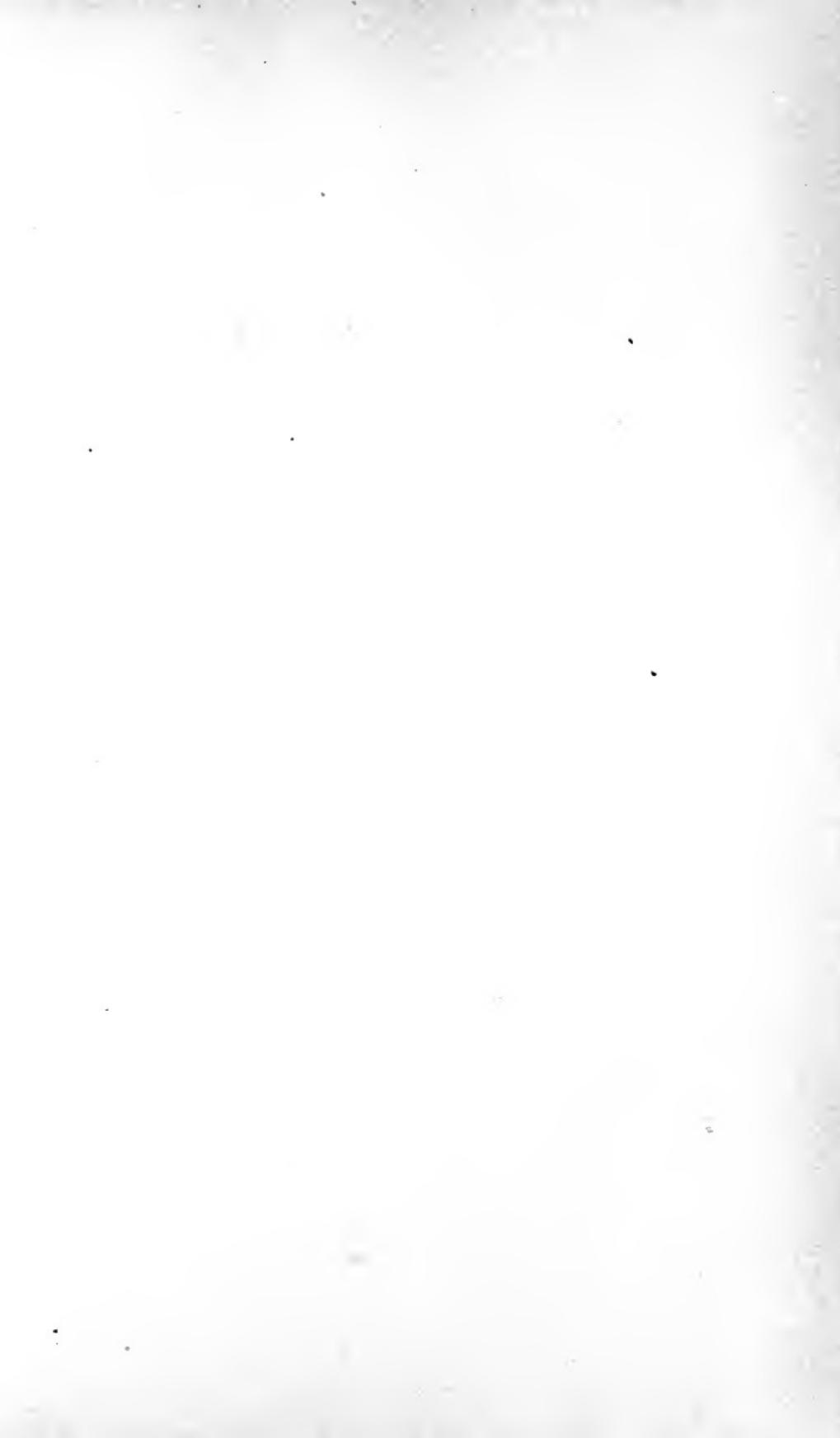


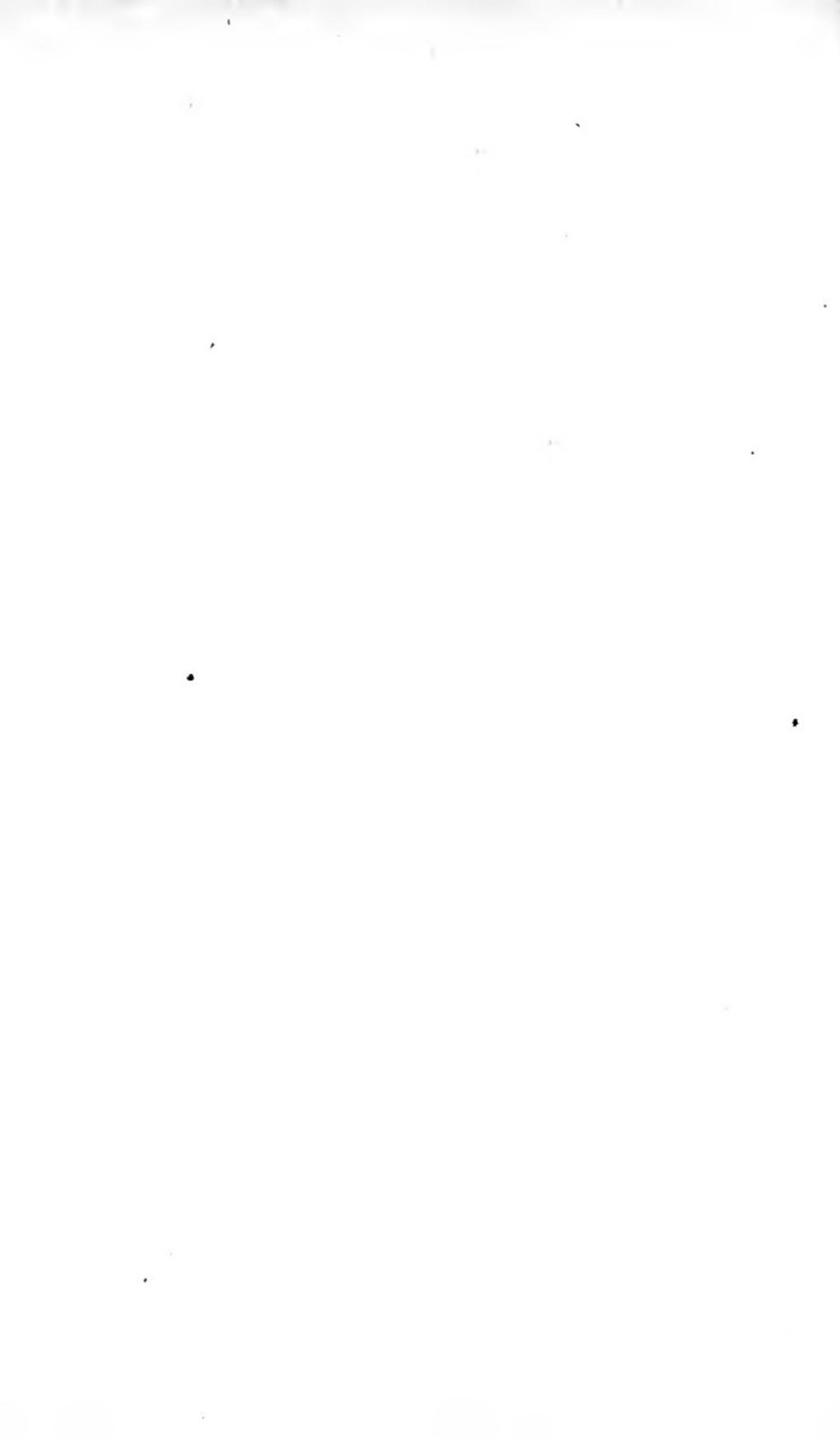








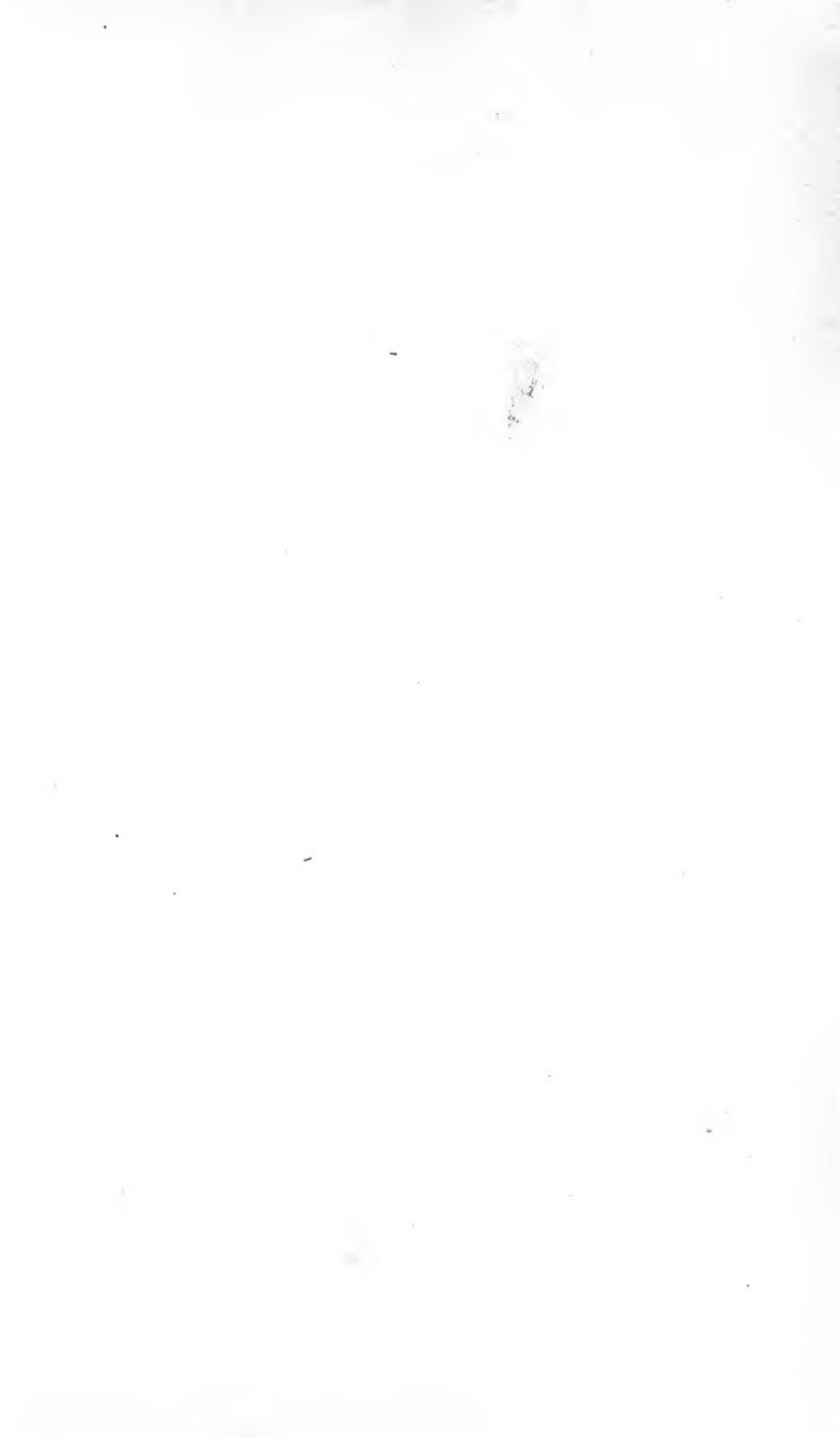


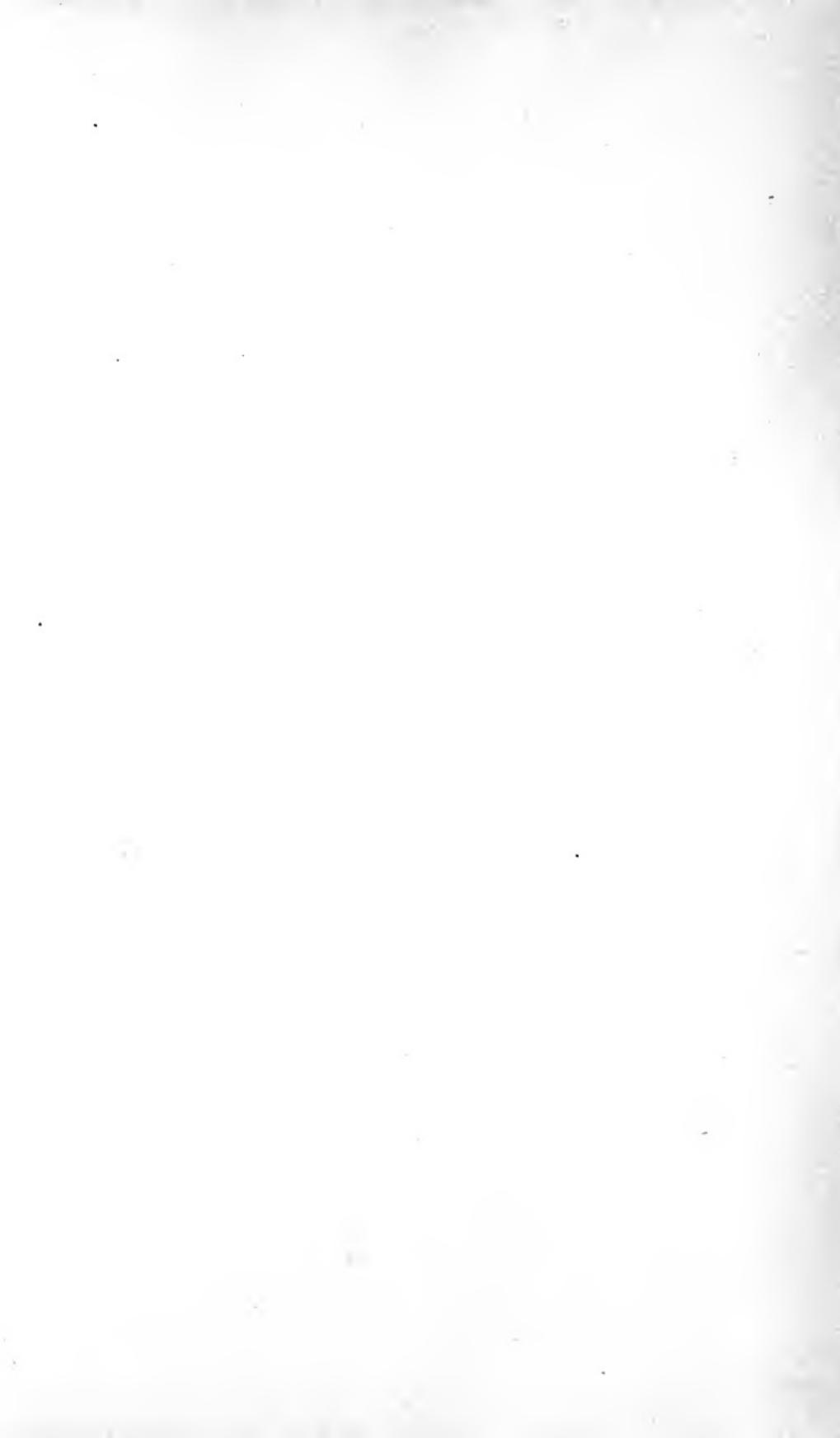






















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